FMC Idaho LLC, Pocatello, Idaho

FMC OU Remedial Design
EXTRACTION ZONE
HYDROGEOLOGIC STUDY WORK PLAN

January 2014

MWH

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LIST OF ACRONYMS

AFLB	American Falls Lake Beds
amsl	above mean sea level
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/s	centimeters per second
COC	contaminants of concern
DQO	data quality objective
EPA	United States Environmental Protection Agency
EMF	Eastern Michaud Flats
FMC	FMC Corporation
FMC OU	FMC Operable Unit
FSP	Field Sampling Plan
ft	feet
ft/day	feet per day
ft^2/day	square feet per day
gpm	gallons per minute
GPS	global positioning system
GWCCR	Groundwater Current Conditions Report for the FMC Plant OU
HASP	Health and Safety Plan
HCS	Hydraulic Containment System
I-86	Interstate 86
IROD	Interim Record of Decision Amendment
MCL	maximum contaminant level
mg/l	milligrams per liter
MS/MSD	matrix spike / matrix spike duplicate
MWH	MWH Americas, Inc.
NTU	Nephelometric tubidity unit
Plan	Groundwater Extraction Zone Hydrogeologic Study Work Plan
PM	Project Manager
POTW	publically owned treatment works
psi	pounds per square inch
PVC	polyvinyl chloride
QAPP	quality assurance project plan
RA	Remedial Action
RAs	Remediation Areas
RD	Remedial Design
SRI	Supplemental Remedial Investigation
SFS	Supplemental Feasibility Study

SOP	Standard Operating Procedure
SWHASP	Site-Wide Health and Safety Plan
TOC	top of casing
UAO	Unilateral Administrative Order
USCS	Unified Soil Classification System

1.0 INTRODUCTION

This Groundwater Extraction Zone Hydrogeologic Study Work Plan (Plan) was prepared to obtain data and information necessary to advance the Remedial Design (RD) for the FMC Operable Unit (FMC OU), Pocatello, Idaho. This Plan details the work and analyses for a detailed hydrogeologic assessment in the extraction zone of the groundwater remedial action Hydraulic Containment System (HCS) located at the northeast boundary of the FMC OU. The HCS is a component of the selected remedy for the FMC OU identified in the Interim Record of Decision Amendment (IROD, EPA 2012) and the Unilateral Administrative Order for Remedial Design and Remedial Action (UAO, EPA 2013). Data collected during this study will be utilized to refine the design of the groundwater remedy selected for the FMC OU. This Plan was prepared pursuant to Section IX., Paragraph 30.d. (Performance Testing) of the UAO and EPA's letter of June 19, 2013 that clarified the intent of the groundwater remedy performance testing.

This study will be performed to obtain more detailed hydrogeologic and water quality data within the groundwater remedy extraction zone preliminarily identified based on the *Supplemental Feasibility Study Report for the FMC Plant OU* (SFS Report, MWH 2010a) groundwater model. More detailed hydrogeologic and groundwater quality data is needed to refine the groundwater model including expected total extraction flow, number and location of extraction wells and combined water quality for purpose of evaluating water management (treatment) options. This Plan describes the collection of groundwater samples from the extraction zone for laboratory analyses and bulk water samples for potential bench-top / jar testing for further evaluation of the water treatment process for extracted groundwater, under either management option A (treatment at the City of Pocatello publically owned treatment works [POTW]) or option B (on-site treatment followed by infiltration in an on-site percolation basin[s]). A subsequent work plan may be recommended for water treatment process evaluation in the event that the bench-top / jar testing (if performed) indicates that a larger scale, on-site evaluation of the water treatment process is necessary to complete the remedial design.

1.1 BACKGROUND

1.1.1 FMC Site Description

A vicinity map of the FMC OU is provided on Figure 1-1 and a site map showing the FMC OU Remediation Areas (RAs) and hydrogeologic study area is provided on Figure 1-2.

1.1.2 Regulatory Background

The IROD was signed by EPA Region 10 on September 27, 2012. The IROD presents the interim remedy for the Site as selected by the EPA. On June 10, 2013, EPA Region 10 issued a UAO to FMC for Remedial Design and Remedial Action (UAO; EPA 2013), EPA Docket No. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-10-2013-0116. The UAO defines the specific actions FMC will undertake to design and implement the selected remedy at the FMC OU in accordance with the IROD. The selected groundwater remedy requires extraction from the shallow aquifer to provide hydraulic containment of groundwater thereby preventing further downgradient migration of FMC OU COCs.

1.1.3 Summary of Hydrology and Hydrogeologic Setting

The EMF Site, and specifically the FMC OU, has been the subject of many environmental investigations. Most notable are the RI as summarized in the *Remedial Investigation Report for the Eastern Michaud Flats Site* (EMF RI Report; Bechtel, 1996), the *Groundwater Current Conditions Report* (GWCCR) *for the FMC Plant Operable Unit* (MWH, 2009a), and the *Supplemental Remedial Investigation* (SRI) *Report for the FMC Plant Operable Unit* (MWH, 2009b). These reports provide detailed information on the results of the investigations conducted at the FMC OU. This section presents a brief summary of the hydrologic and hydrogeologic investigations, a more detailed discussion is contained in Section 2 of this Plan.

Major surface water features of the region near the FMC OU include the Snake River, Portneuf River, and the American Falls Reservoir. There are no naturally-occurring perennial surface water systems within the FMC OU. Surface water runoff from the FMC OU former operations area from precipitation is infrequent and is entirely contained within the FMC Plant Site property. Surface water runoff will continue to be entirely contained within the FMC Plant Site property during and after implementation of the selected remedy.

Groundwater at the EMF Site flows northward from the western and central portions of the FMC OU and converges with flow of groundwater from the west and northwest. Groundwater from the western and central portions of the FMC OU flows eastward, south of I-86, and joins groundwater from the Joint Fence Line Area and from the Simplot Plant. Virtually all groundwater from beneath the EMF facilities ultimately discharges to the Portneuf River between Batiste Spring and the spring at Batiste Road (aka Swanson Road Springs). Groundwater elevation contours for the shallow aquifer zone and generalized flow direction are shown on Figure 1-3.

Groundwater depths range from more than 150 feet (ft) below ground surface (bgs) in the southern portion of the FMC OU to 45 ft bgs in the northwestern area of the FMC plant area (Figures 1-4a and 1-4b; Cross Section). In the northern portion of the FMC OU, groundwater is approximately 60 ft bgs. The SRI sampling encountered groundwater at depths typically greater than 90 ft bgs at the FMC plant area. As presented in Figure 1-3, groundwater flow beneath the former operations area generally flows to the north from the Bannock Range and then to an east-northeasterly flow as the Bannock Range groundwater merges with the Michaud groundwater system. FMC- and Simplot-impacted groundwater discharges and mixes with the Portneuf River in the area between and including Swanson Road Spring and Batiste Spring, and then migrates into the Off-Plant OU as surface water.

1.2 PURPOSE AND OBJECTIVES OF HYDROGEOLOGIC STUDY

This Plan presents the elements for implementing a study to collect additional data that will be evaluated and incorporated in the final design of the HCS. The full-scale HCS will be designed to capture impacted shallow groundwater before it can migrate beyond the FMC Plant Site boundary. The full-scale HCS will be designed to effectively capture upgradient impacted groundwater, thus containing and extracting groundwater before it migrates off-site. The purpose of this Plan is to present the layout for the hydrogeologic study and evaluation criteria, a quality assurance project plan (QAPP) and the processes to be utilized for data reduction, review, and reporting.

The HCS will consist of a network of extraction wells, located along the northeastern boundary of the FMC Plant Site area of the FMC OU that will capture impacted shallow groundwater before it can migrate downgradient beyond the FMC OU boundary (Figure 1-3). Groundwater modeling as described in the *Groundwater Model Report for the FMC Plant Operable Unit*, (MWH, 2010b) indicates that five extraction wells will be sufficient for hydraulic capture (containment) of the remaining contaminants of concern (COC)-contaminated groundwater plume before it leaves the FMC Plant Site. During the full-scale HCS, the extracted groundwater will be treated by one of two management options: A) discharge for treatment at the City of Pocatello POTW, or B) on-site treatment followed by discharge to a percolation/infiltration basin(s) located in the western undeveloped portion of the FMC OU. This Plan details the study that FMC will conduct utilizing three extraction wells to assess the hydrogeological characteristics of soils in the planned extraction zone and the testing, data evaluation, and reporting associated with this study. The study results will be used to develop the final design of the HCS and will assist in selecting between the water management options. The final design will specify additional extraction wells (expected to total five wells) to provide complete capture of COC-contaminated groundwater.

1.3 HYDROGEOLOGIC STUDY GENERAL APPROACH AND PROCESS

Containment (i.e., hydraulic capture) of impacted groundwater near the northeast FMC Plant Site boundary is expected to be achieved by installation of a HCS and subsequent pumping of groundwater with extraction wells (see Figure 1-3). The HCS and its associated monitoring network will be designed and installed based on the data collected during this Hydrogeologic Study.

Predictive groundwater modeling indicates that five extraction wells, or possibly fewer, likely will be sufficient for hydraulic capture (containment) of the remaining plume before it migrates beyond the FMC OU downgradient boundary. This Plan presents a phased investigative approach prior to finalizing the design and implementation of a full-scale HCS.

1.3.1 Phase I HCS Installation

The HCS will be installed in two distinct field work phases, as necessary. Phase I will consist of the installation of three extraction wells strategically placed across an area to intercept COC-impacted groundwater (see Figure 1-3) and installation of six piezometers that will be utilized to monitor the overall containment (i.e., capture zone). Field procedures for well installation and other activities are further discussed in Section 3.0 and also detailed in Appendix A.

1.3.2 Phase I HCS Pump Tests

Variable pumping rate step-drawdown tests will be performed for a duration of approximately six hours (two hours for each of the three predetermined discharge rates as shown in Table B-3 of Appendix B, though final rates may be revised based on well development results) at each of the three extraction wells to determine specific capacity and optimal pumping rates for each well. A single 24-hour constant rate aquifer test will be performed on the western extraction well to determine aquifer hydraulic parameters. Following the step-drawdown and 24-hour constant rate pumping tests, all three Phase I extraction wells will then be pumped simultaneously for a 72-hour hydraulic containment test. During the 24- and 72-hour test, the water level from select monitoring wells and piezometers will be measured and recorded. The water level data will be evaluated to determine impacts (groundwater drawdown) on the aquifer and the overall capture zone. These procedures are further described in Section 3.0 and in Appendix B. The extracted groundwater from the testing will be managed as described in Standard Operating Procedure (SOP) number 04 (Investigation Derived Waste) contained in Appendix D. Based on over 20 years of groundwater monitoring results at the site, the extracted water is expected to be non-hazardous and will be utilized for dust-suppression activities on site. Alternatively, if the extracted groundwater is determined to be hazardous, arrangements for off-site disposal in accordance with applicable requirements will be made.

1.3.3 Groundwater Sample Collection

Groundwater quality samples will be collected and analyzed from the newly installed extraction wells for site COCs and potential bench-top / jar testing for further evaluation of water treatment under option A (discharge and treatment at the City of Pocatello POTW) or option B (on-site treatment followed by infiltration/evaporation). A subsequent work plan may be recommended for water treatment process evaluation in the event that the bench-top / jar testing (if performed) indicates that a larger scale, on-site evaluation of the water treatment process is necessary to complete the remedial design. The six piezometers and area monitoring wells located proximate to the first three extraction wells will be used to monitor water levels during aquifer tests and to provide water-level drawdown data for capture zone definition and future HCS design. This information will be presented in the Preliminary (30%) RD specified in the UAO. The monitoring and sampling locations are further specified in Section 3.0 of this Plan. Section 4.0 presents the QAPP.

1.4 HYDROGEOLOGIC STUDY WORK PLAN ORGANIZATION

The remainder of this document is organized as follows:

- Section 2.0 – FMC OU Hydrogeology and Groundwater Modeling summary
- Section 3.0 – Hydrogeologic Study design
- Section 4.0 – QAPP
- Section 5.0 – Data Reduction, Review, and Reporting
- Section 6.0 – Health and Safety Plan
- Section 7.0 – Deliverables and Schedule
- Section 8.0 – References
- Appendix A – Extraction Well and Piezometer Installation Field Procedures
- Appendix B –Procedures for Conducting Step Drawdown Tests, Constant Discharge Aquifer Tests, and Multiple Well Containment Tests
- Appendix C –Groundwater Sampling Field Form
- Appendix D – Standard Operating Procedures

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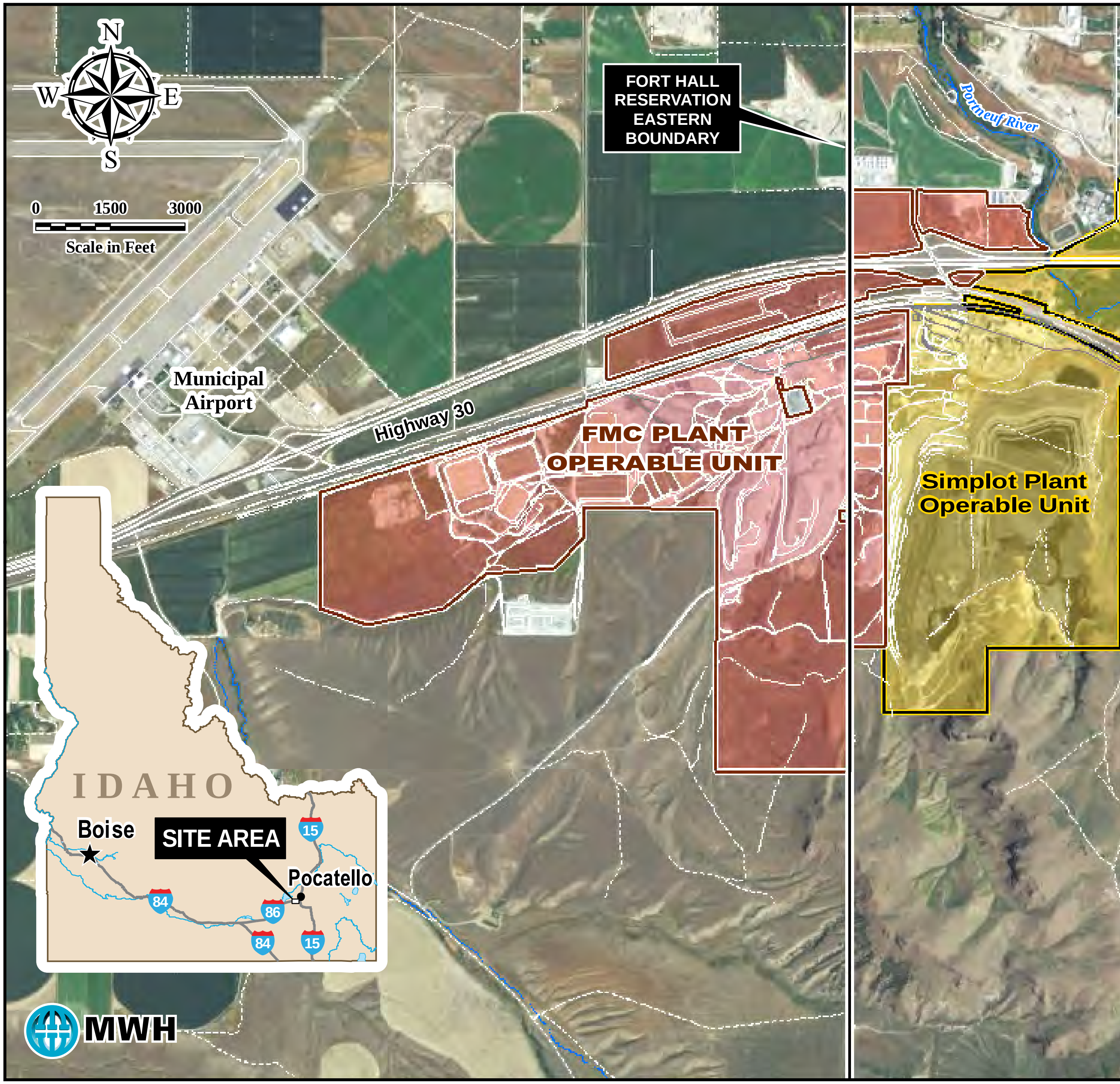

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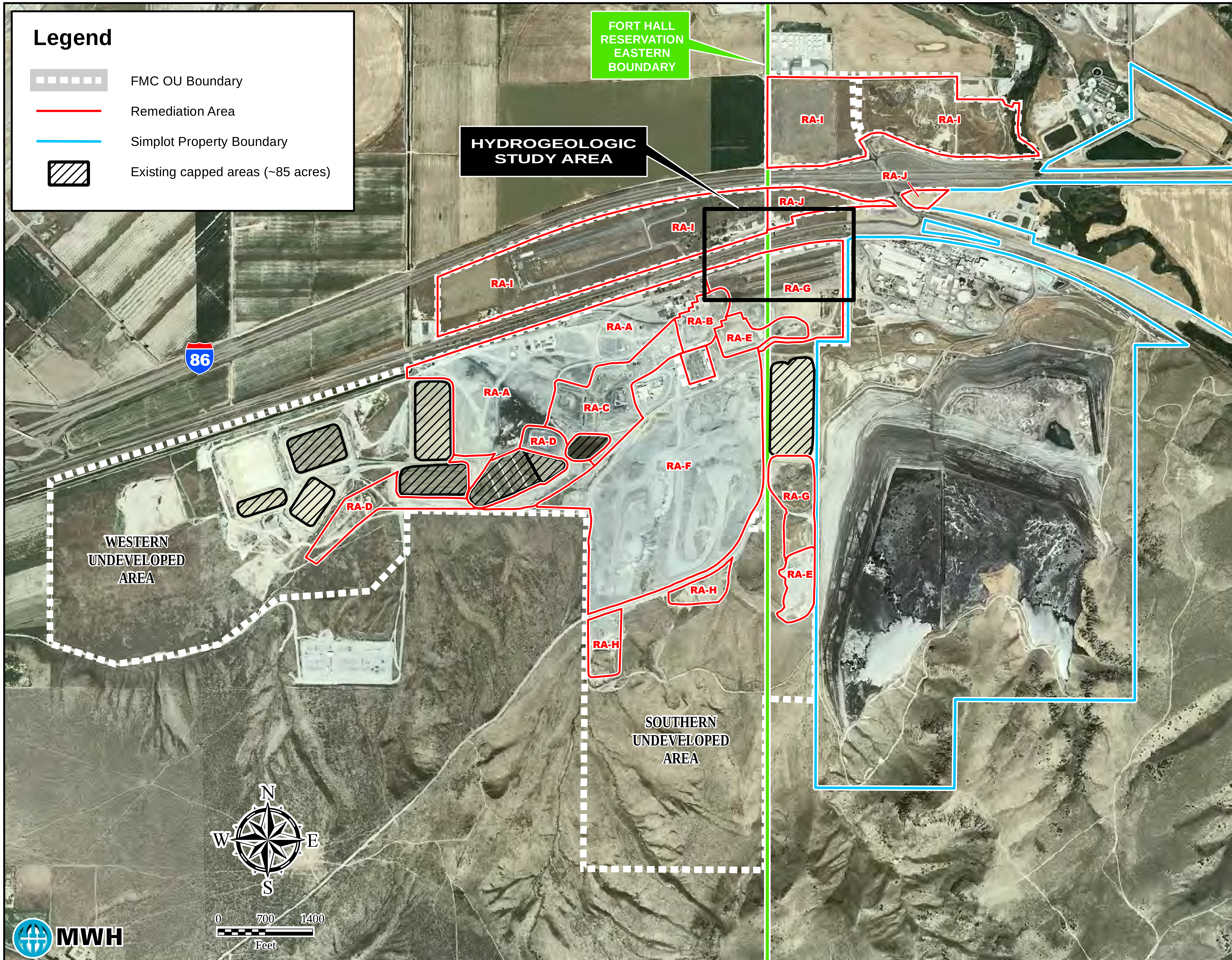
HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 1-1

FMC OPERABLE UNIT VICINITY MAP



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HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 1-2

FMC OPERABLE UNIT SITE PLAN

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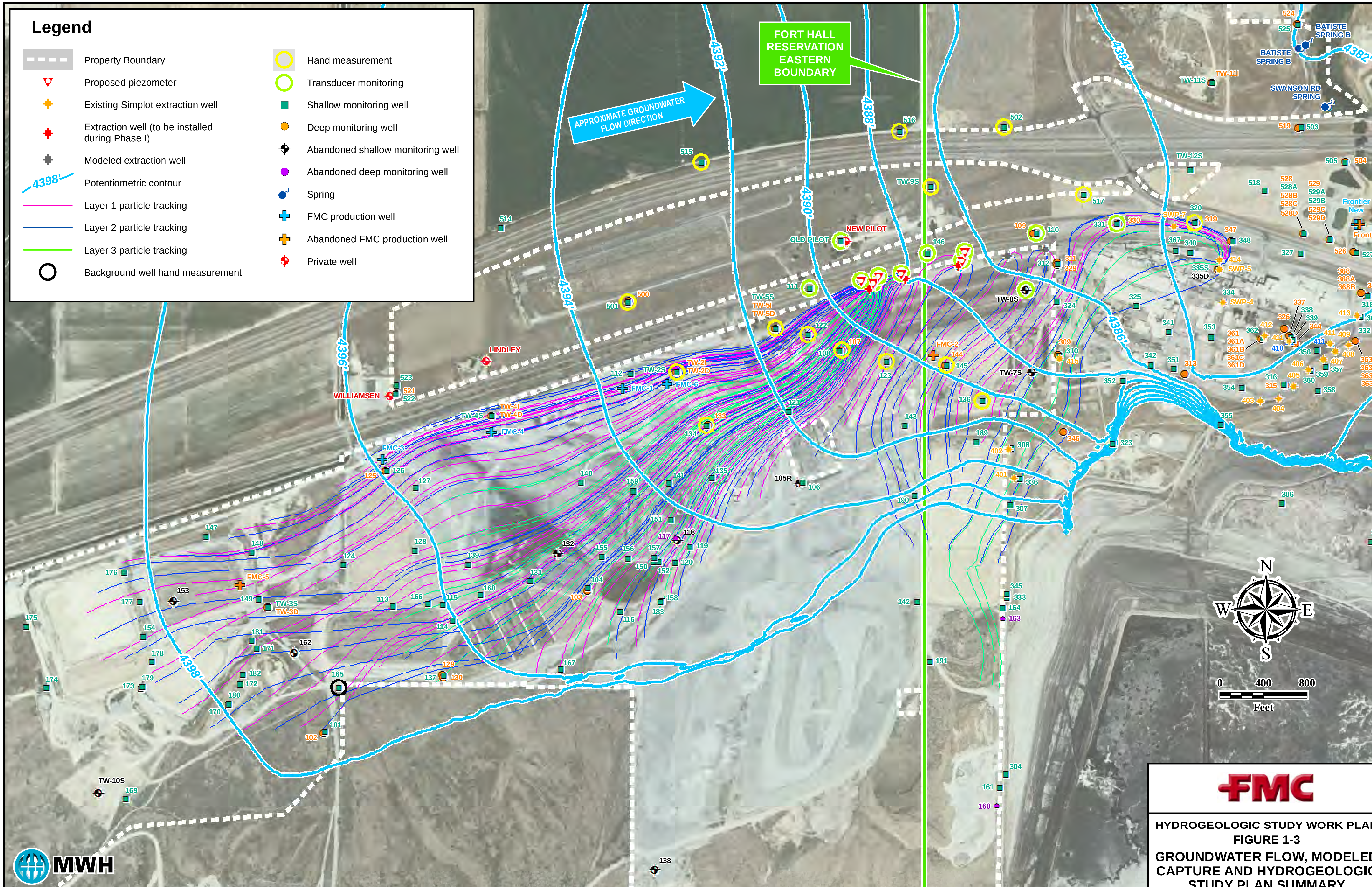

HYDROGEOLOGIC STUDY WORK PLAN
FIGURE 1-3
GROUNDWATER FLOW, MODELED CAPTURE AND HYDROGEOLOGIC STUDY PLAN SUMMARY

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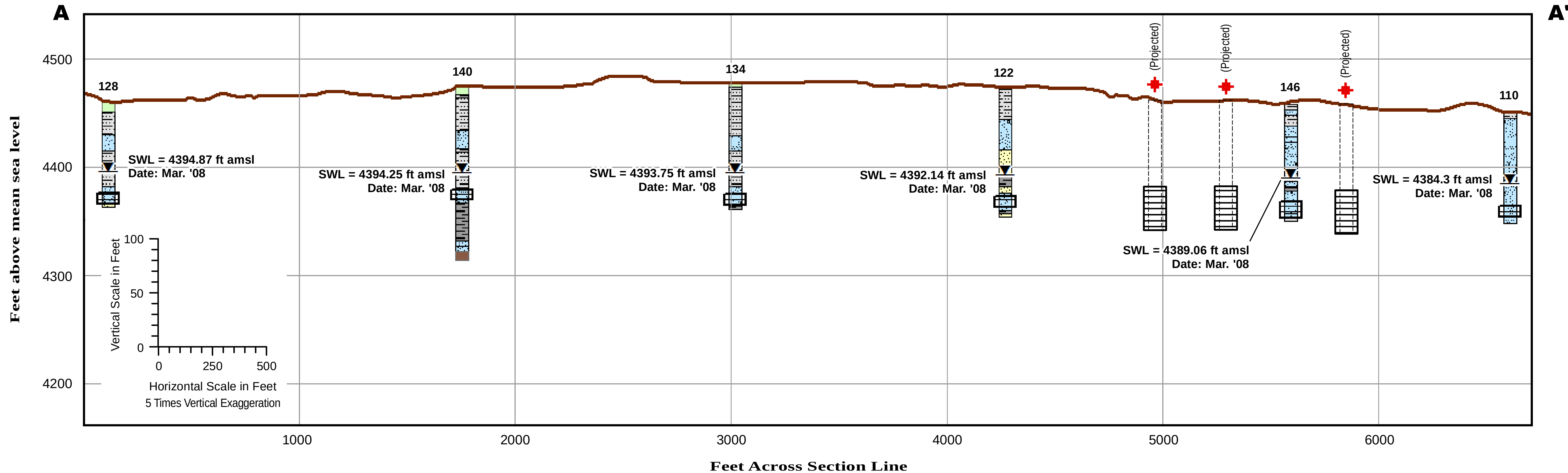

EXPLANATION

- Groundwater Level
- Well Screen Interval
- Asphalt/Fill
- Clay
- Silt
- Sand
- Gravel
- Bedrock
- Extraction Well - Phase I
- Modeled Extraction Well
- Monitoring well used for cross sections
- Cross Section Line
- FMC Property Boundary
- 4394 Potentiometric Surface Contour
- SWL Static Water Level
- ft Feet
- amsl Above Mean Sea Level

FMC

HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 1-4a

CROSS SECTION A-A'

DATE: 15 July 2013

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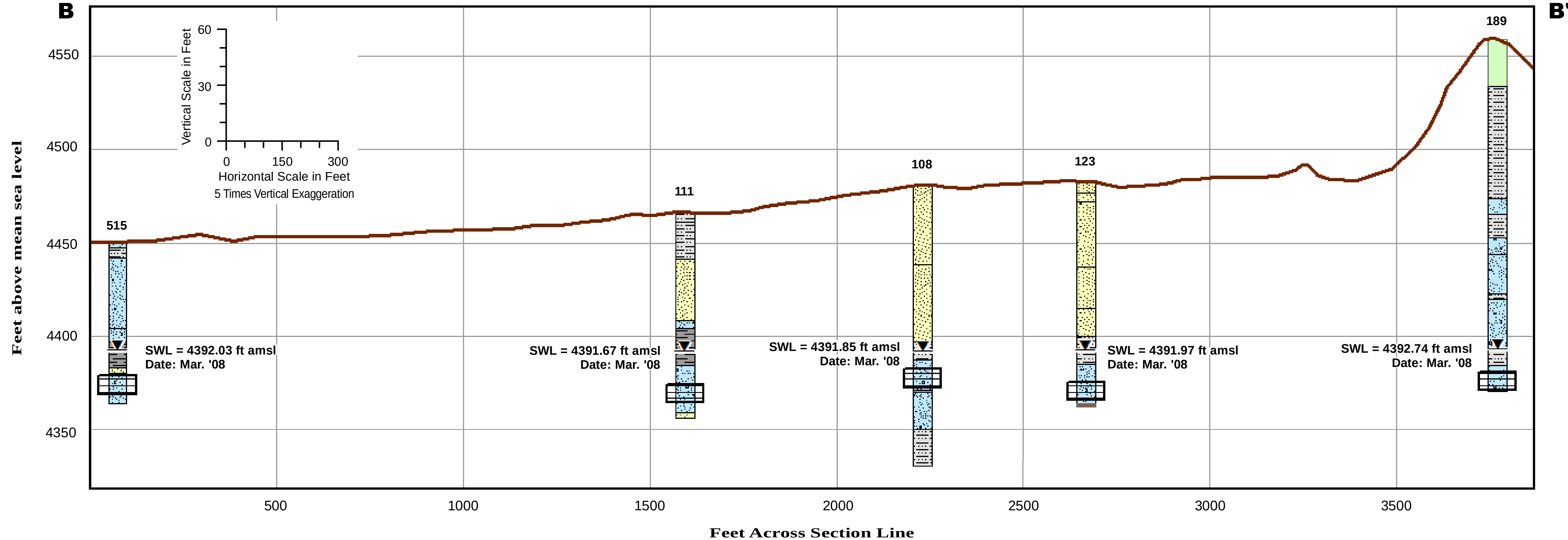

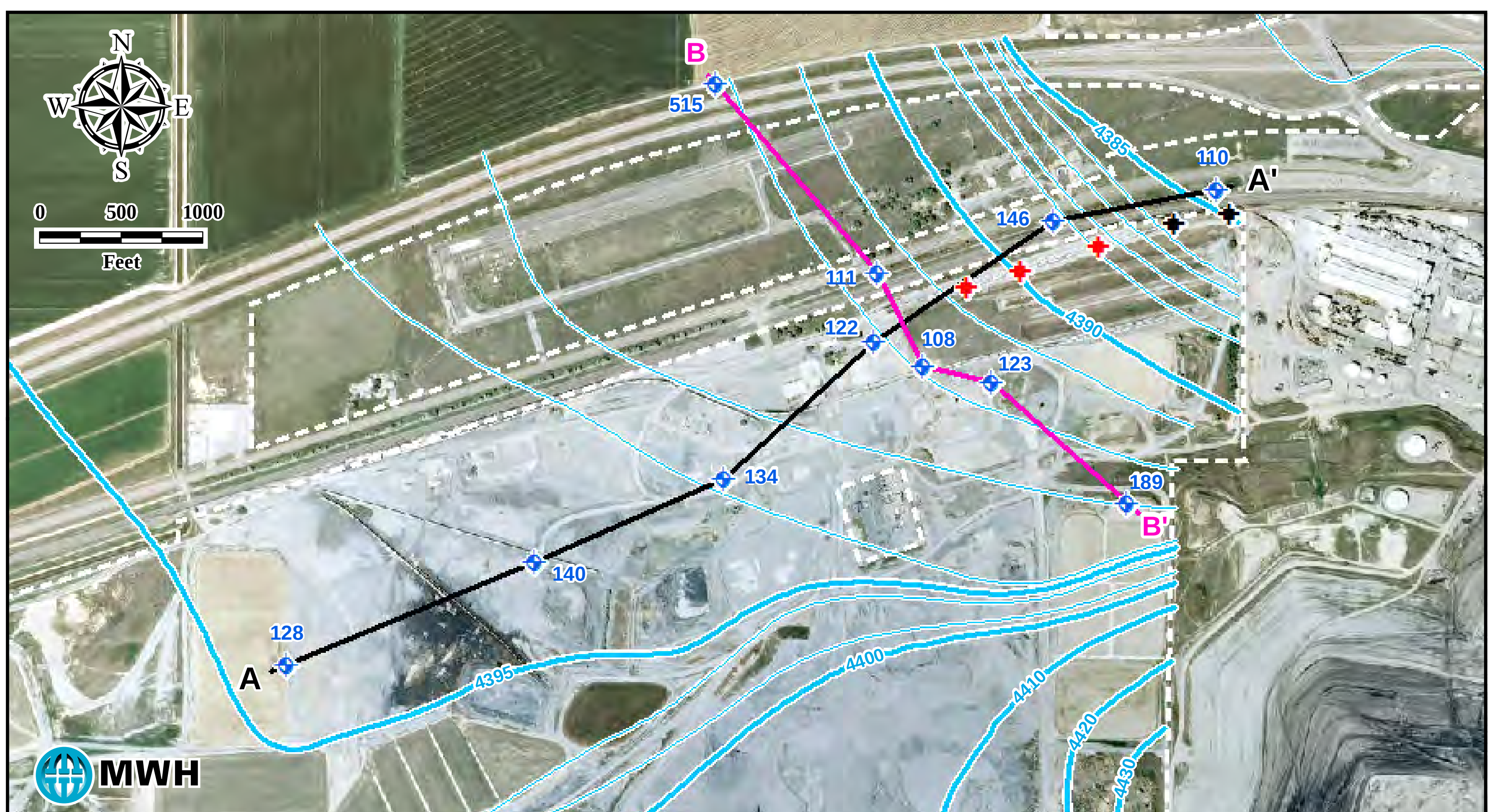

EXPLANATION

Groundwater Level

Well Screen Interval

Asphalt/Fill

Clay

Silt

Sand

Gravel

Bedrock

Extraction Well - Phase I

Modeled Extraction Well

Monitoring well used for cross sections

Cross Section Line

FMC Property Boundary

4394 Potentiometric Surface Contour

SWL Static Water Level

ft Feet

amsl Above Mean Sea Level

FMC

HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 1-4b

CROSS SECTION B-B'

DATE: 15 July 2013

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2.0 FMC OU HYDROGEOLOGY AND GROUNDWATER MODELING SUMMARY

This section presents a summary of the site hydrogeology, nature and extent of contamination and groundwater modeling results used to determine the initial HCS extraction well arrangement.

2.1 HYDROGEOLOGY

This section presents the geology and hydrogeology of the FMC OU. For greater detail see the EMF RI Report (Bechtel, 1996) and the GWCCR (MWH, 2009a).

2.1.1 Regional Hydrogeologic Setting

The EMF Site is located at the southern margin of the Eastern Snake River Plain which is underlain by basalt and gravel aquifers that are recharged mostly by underflow from surrounding mountain ranges. Some recharge occurs as irrigation return and deep percolation from precipitation. Several rivers flow onto the Snake River Plain, where surface water infiltrates and ultimately discharges to the Snake River. Groundwater flow through the basalts of the Snake River Plain occurs primarily in thin interflow zones: thin gravel and fracture zones between basalt flows and in the fracture of the basalts (some of the basalts are columnar basalts, with a large interconnected fracture network). Regionally, the Snake River defines the base level for some smaller rivers such as the Blackfoot and Portneuf Rivers. The Portneuf River drains approximately 1,250 square miles, flowing across the Eastern Michaud Flats to the American Falls Reservoir, where it joins the Snake River.

The Michaud Flats are underlain by the same prolific basalt and gravel aquifers. These aquifers are recharged by underflow from the adjoining Bannock and Pocatello mountain ranges and from significant down-valley underflow from the Pocatello Valley aquifer. Smaller drainages also provide underflow to the aquifers (see EMF RI Report Figure 3.3-2, provided in Appendix B of this Plan). Direct infiltration from precipitation and irrigation return are other recharge sources. Within the mountainous areas, there are no regionally continuous hydrostratigraphic units. At the transition between mountainous areas and flatlands, there are alluvial fan deposits where groundwater flow occurs primarily within sand and gravel lenses.

Within the Michaud Flats, the aquifer system can be divided into a shallow and a deeper aquifer. The shallow aquifer is the Michaud Gravel which is typically overlain by a silt aquitard. The aquitard is generally saturated from 10 to 30 feet above the gravel, but is locally unconfined. The deeper aquifer is comprised of the gravel and volcanics of the Sunbeam and Starlight Formations, and the Big Hole Basalt. The deeper aquifer is the primary water-producing aquifer within the Michaud Flats. The deeper aquifer underlies the AFLB, the regional aquitard between the shallow and deeper aquifers (Houser, 1992). Groundwater flow within the regional aquifer system discharges to the Portneuf River (via springs and base flow contribution), American Falls Reservoir, or to one of the numerous springs and seeps in the Fort Hall Bottoms. Groundwater discharges to the Portneuf River along the reach from I-86 downstream to the American Falls Reservoir. The river gains significant flow along this reach as groundwater discharges through the riverbed and springs on both the east and west sides of the channel. The Pocatello sewer treatment plant (STP) also contributes some flow along this river reach.

2.1.2 EMF Site Hydrogeology

The EMF Site hydrostratigraphic framework is generally consistent with the regional framework. Three distinct hydrogeologic areas were delineated in the vicinity of the EMF facilities on the basis of lithologic data, stratigraphic relationships, groundwater flow characteristics, and water chemistry. These areas are the Michaud Flats, Bannock Range, and Portneuf River (see EMF RI Report Figure 3.3-3, in Appendix B). Within the Bannock Range area there were no continuous hydrostratigraphic units delineated during the RI. Starlight Formation volcanic flows and interflow units were not correlative, and the distribution of rock types and saturated materials encountered in the RI borings is best described as highly heterogeneous.

The transition zone between the Bannock Range hydrogeologic area and the Michaud Flats is characterized by small coalescing alluvial fans that are also relatively heterogeneous. In the Michaud Flats, distinct shallow aquifer and deeper aquifer zones were identified in the RI (see EMF RI Report Figure 3.3-4, in Appendix B). The shallow aquifer is a 10 to 20-feet thick gravel and sand aquifer that is locally overlain by a silt aquitard (EMF RI Figure 3.3-5, in Appendix B). The deeper aquifer is the gravel unit of the Sunbeam Formation and the underlying basalt and rhyolite. The unconsolidated gravel and the underlying volcanic lithologies do not appear to have a large permeability contrast, nor is there an intervening aquitard between these units. Therefore, both units constitute the deeper aquifer in the Michaud Flats area.

The AFLB form an aquitard that separates the shallow and deeper aquifers within the Michaud Flats area. These lacustrine clays and silts have very low permeability and are regionally extensive, extending from the Bannock Range area to the American Falls Reservoir, where they crop out along the reservoir embankment. As shown on EMF RI Figure 3.3-6 (included in Appendix E), the top of the AFLB is expected to be encountered at an elevation between 4,350 and 4,365 feet above mean sea level (AMSL) in the extraction zone at the northeast property boundary of the FMC Plant site. The range of elevations for the top of the AFLB reported in the EMF RI has been confirmed and refined beneath the Simplot plant site. As shown on Figure 3-1 of Simplot's Supplemental Subsurface Investigation in the Phosphoric Acid Plant Area Report (July 2013), the top of the AFLB was encountered at an elevation between 4,350 and 4,375 feet AMSL (the AFLB was reportedly encountered at 4,381 AMSL in one boring).

As shown on EMF RI Report Figures 3.1-6A and B and 3.3-4 (included in Appendix E), the AFLB is about 35 to 15 feet thick based on the lithologic logs from wells 139, 140 and 133 (western ponds area), well 330 (east of FMC and Simplot joint north plant property boundary) and well 500 (north of I-86). A review of deep boring logs from well 109 (next to well 110 in the northeast corner of the plant site), 140 (western ponds area) and well 109 (next to well 108 in the central plant area) shows a depth to the top and thickness of the AFLB consistent with EMF RI Figures 3.3-6 and 3.3-4 respectively.

The AFLB are not present along part of the Portneuf River in the area of Batiste Springs and Wells 524/525 south to Well 520 (see EMF RI Figure 3.3-6, in Appendix B). The Bonneville Flood may have scoured the AFLB, consistent with Trimble's (1976) map of boulder deposition patterns that indicate a main flood channel in this area. Elevation contours on the top of the AFLB suggest a slight dip to the north. Just to the south of I-86, there is an elongated, east-west depression in the AFLB surface, which may also be an erosional feature of the flood (see EMF RI Figure 3.3-6, in Appendix B).

In areas immediately adjacent to the Portneuf River, where the AFLB are not present (as discussed above) and in the Bannock Range area, distinct shallow and deeper aquifers cannot be delineated. In the Bannock Range and Portneuf River areas, the monitoring wells in well pairs were classified as shallow and deep without respect to specific hydrostratigraphic units.

2.1.3 Aquifer Test Results

EMF Site pumping test and slug test results are detailed in Section 3.3.2.1 of the EMF RI Report (see EMF RI Table 3.3-1 Hydraulic Conductivities and Transmissivities of EMF Aquifer System, provided in Appendix B) and are summarized below.

In the Bannock Range area, hydraulic conductivity typically ranges from 0.00001 centimeter per sec (cm/s; 0.03 feet per day [ft/day]) to 0.1 cm/s (283 ft/day) in shallow and deeper zones. Although the lithology is highly heterogeneous, the hydraulic conductivity is fairly consistent throughout much of this area as defined by Wells 142, 300, 301, 304, 306, 323, 325, PEI-2, and PEI-5 (Figure 1-3). Hydraulic conductivities are higher at Wells 307, 308, and 333, which are located along the joint fenceline of Simplot and FMC. The higher hydraulic conductivities in this area are associated with a small, narrow, and deep relict sediment-filled stream channel originating within the Bannock Range (see EMF RI Figures 3.3-2 and 3.3-7A, in Appendix B).

Estimated hydraulic conductivity values in the Michaud Flats shallow aquifer range from 0.01 cm/s (30 ft/day) to 0.36 cm/s (1,000 ft/day). The highest values were at Wells 150 (near Pond 8S) and 153 (near Pond 16S). Slightly lower values were associated with the depression in the AFLB, and two of the lowest values were measured in Wells 515 and 516, north of this depression. In the deeper aquifer hydraulic conductivities appear to have an increasing trend to the north. Relatively low values were measured in deeper Wells 103 and 107 with slightly higher values at Well 500 and 133.

Transmissivity data from Jacobson (1984) indicate very high hydraulic conductivities in the deeper aquifer throughout the area north of I-86 (see EMF RI Table 3.3-1, in Appendix B). South of I-86, a transmissivity of 227,000 square feet per day (ft^2/day) was calculated at Simplot production well SWP-7. When SWP-5 was installed and developed, 3 feet of drawdown was measured after 48 hours of pumping at 4,100 gpm, indicating it has a higher transmissivity than SWP-7. Irrigation wells tested in the Michaud Flats had transmissivities ranging from 21,900 to 444,000 ft^2/day (Jacobson, 1984).

The bouldery gravel aquifer in the Portneuf River area has the highest hydraulic conductivity in the area. Calculated values ranged from 0.01 cm/s (28 ft/day) to 1.7 cm/s (4,800 ft/day). Most of the slug test results from the Portneuf River area indicate hydraulic conductivities are greater than 0.36 cm/s (1,000 ft/day). Hydraulic conductivities appear to be similar in the shallow and deeper wells throughout the Portneuf River area.

2.1.4 Groundwater Elevations, Flow Patterns and Vertical Gradients

Depth to groundwater in EMF Site wells ranges from over 150 feet in the Bannock Range to less than 10 feet near the Portneuf River (groundwater reaches the ground surface at the springs). The groundwater elevations in the Bannock Range were up to 4,629 feet amsl (above mean sea level), as measured in PEI-1. Approximately 8,500 feet north the groundwater elevations were 4,383 feet amsl at Batiste Spring along the Portneuf River (see EMF RI Figure 3.3-8F, in Appendix B).

There are seasonal water level fluctuations in the Michaud Flats, typically on the order of 2 to 4 feet, which may be associated with irrigation withdrawal and recharge patterns. Overall, the water levels indicate no long-term decrease in water levels at the site. Water levels in the shallow and deep wells have typically fluctuated within 4 to 8 feet between maximum and minimum measured levels over the 15 to 18 year period of monitoring for most of the wells. Maximum water levels were generally observed in the mid- to late 1990s during a cycle of average and above average regional precipitation during the monitoring period for most wells. Minimum water levels were typically observed in the 2001 and 2002 period that coincided with several years of significantly below average precipitation in the region. Water levels have slowly rebounded in recent years but generally have not recovered to levels measured during the 1990s.

Groundwater elevation potentiometric contour plots for the shallow aquifer were prepared for each quarterly sampling event from June 1992 through May 2008. The potentiometric contour map for the shallow aquifer in May 2008 is presented in Figure 1-3. Potentiometric contour maps from June 1992 through May 2008 are provided in Appendix B of the GWCCR (MWH, 2009a). These contour patterns are very consistent from quarter to quarter and year to year. Several key features are evident in the contour patterns.

- There are very steep horizontal hydraulic gradients in the Bannock Range.
- Within the western part of the monitoring network, there is a slight northeast-trending trough in the groundwater surface extending through the area of Wells 170, 168, 139 and 140 (northeast of Pond 15S).
- There is a distinct increase in the horizontal hydraulic gradient in the vicinity of Wells 146 and TW-9S, and a decreasing hydraulic gradient further east, in the vicinity of Wells 517, TW-11S and TW-12S.
- Shallow groundwater contour patterns do not appear to be influenced by production wells pumping from the deeper aquifer nor from the dramatic decrease in pumping from production wells FMC-1 and FMC-3 following plant shutdown in December 2001.

General flow patterns described by the hydraulic head contours indicate that groundwater flows north off the Bannock Range based on the steep hydraulic gradients observed in the low permeability materials. When this Bannock Range flow enters the highly permeable aquifer materials beneath Michaud Flats and the Portneuf River, groundwater flow converges sharply, with all shallow Bannock Range groundwater ultimately discharging along a short reach of the Portneuf River at Batiste Spring, the Spring at Batiste Road (aka Swanson Road Springs), and as bank seeps and baseflow to the river in the reach bounded by these springs just north of I-86.

Horizontal groundwater seepage velocities, calculated from hydraulic conductivities, horizontal gradients, and estimated porosity, are up to 12 ft/day in the Portneuf River area, 0.4 ft/day in the Bannock Range area, and from 1 to 11 ft/day in the Michaud Flats area. The variable seepage velocities calculated in the Michaud Flats area illustrate the effects of variable horizontal gradients and the wide range of hydraulic conductivities calculated for this area (see EMF RI Table 3.3-1, in Appendix B). The consistently high seepage velocities in the Portneuf River area are indicative of the very high hydraulic conductivities associated with the Bonneville Flood deposits.

Vertical head differentials were measured in well pairs installed during the EMF RI and during previous investigations. Vertical head differentials are one measure of the flow potential between shallow and deeper saturated zones (the other factor is the vertical hydraulic conductivity). The vertical head differentials also provide indications of the direction of the flow or gradient between shallow and deeper zones.

The overall pattern of vertical differentials shows that in the area along the flanks of the Bannock Range there is a downward vertical hydraulic gradient. Well pairs 130/137 and 101/102 had persistent downward gradients, and well pair 103/104 had a slight upward gradient (less than 0.10 foot head differential). This pattern is still observed based on the water levels at well pairs 101/102, 130/137 and 103/104 measured during May 2008. Water levels measured in May 2008 for site-wide shallow/deep well pairs are shown on Table 2.2-1 of the GWCCR. Further north, vertical gradients were upward in well pairs 134/133, 117/118 (now abandoned), 107/108, TW-5S/TW-5I, and 500/501 during the EMF RI. During the EMF RI, there was a downward gradient measured in well pair 125/126, located near production well FMC-1, which draws water from the deeper aquifer and may have induced a local downward gradient. However, based on measurements in May 2008, the slight (less than 0.1 foot) downward gradient at well pair 125/126 does not relate to pumping of FMC's production well FMC-1, as this well has not been pumped in over eight years.

From the area along the joint facilities' fenceline out to the Portneuf River, there were relatively large upward vertical head differentials measured in the well pairs 309/310, 329(311)/312, 109/110, 319/320, TW-11I/11S, 504/505, 503/519, and 315/316 during the EMF RI. In these well pairs the water levels in the deeper wells were typically 2 to 6 feet higher than water levels in the shallow wells. The May 2008 water level measurements at well pair 109/110 showed the water level in the deeper well (Well 109) was 4.6 feet higher than the shallow well (Well 110) with a calculated upward vertical gradient of 0.09 feet per foot, consistent with the EMF RI findings in this area of the site.

2.1.5 Summary of Groundwater Hydrogeology

- Hydraulic gradients (and inferred groundwater flow directions) within the EMF study area are very stable and have not changed significantly, as demonstrated by 18 years of quarterly monitoring.

- Migration of site-related constituents from the shallow groundwater zone to the deeper zone is inhibited by upward vertical hydraulic gradients and the presence of confining strata (silt and clay units of the AFLB) throughout large portions of the EMF study area. As described in the GWCCR, during 2002, deep aquifer zone wells within the FMC Plant OU were selected for sampling and analysis for the routine CERCLA and an expanded parameters list. This special program was conducted in response to EPA questions regarding the EMF RI findings that the deep aquifer zone was not impacted in the FMC western ponds area and EMF joint fenceline area. All of the sample results were below the representative (background) levels with the exception of the fluoride result for well 125 (0.98 mg/l) which was slightly higher than the Michaud representative concentration (0.80 mg/l), but was far below the comparative value of 4 mg/l. EPA also requested and FMC agreed to again monitor the deep wells on the FMC OU during 2009 as documented in the Summary of Results for the FMC 2Q2009 Groundwater Monitoring Event, submitted to EPA on July 30, 2009. In summary, the results from the 2009 sampling of deep wells located near the FMC Plant Site northern property (wells TW-5D and 109) confirm the EMF RI finding that FMC impacted groundwater is not migrating beyond the Plant Site in the deep groundwater zone. Groundwater underflowing the EMF facilities discharges to the Portneuf River.

- Northward flow of impacted groundwater from the western ponds area (i.e., Pond 8S and the old phossy ponds including Ponds 3E - 6E, now beneath the RCRA lined and capped ponds Pond 15S and Phase IV Ponds) and central plant areas of the FMC Plant Site is limited to the area south of I-86, due to the effects of converging flow of groundwater from the Michaud aquifer to the west and northwest.

- Virtually all groundwater underflowing the EMF facilities discharges to the Portneuf River at Batiste Spring, the Spring at Batiste Road (aka Swanson Road Springs), and as bank seeps and baseflow to the river in the reach bounded by these springs.

2.2 SUMMARY OF GROUNDWATER MODELING

A groundwater model was constructed for the FMC OU and presented in the *Groundwater Model Report for the FMC Plant Operable Unit*, (MWH, 2010b). The final calibrated groundwater flow and transport model and predictive simulations of remedial alternatives (e.g., refinement of the groundwater remedial alternatives such as extraction well locations and flow rates; assumptions regarding the J.R. Simplot Plant OU sources and sinks) were modified based on agency feedback and guidance obtained during these meetings. The groundwater model was constructed and predictive simulations were performed in four general steps as follows:

1. The three-dimensional groundwater flow model was developed and refined during calibration to provide the underlying flow regime for contaminant fate and transport simulations;

2. The contaminant transport model was developed for the site related groundwater constituents arsenic, total phosphorus / orthophosphate, and potassium and refined during calibration (plume matching) to improve estimates of transport parameters;

3. The modeled groundwater remedial alternatives 2 and 3 extraction well configurations and pumping rates were developed and refined to meet appropriate capture and well drawdown criteria; and,

4. The predictive simulations were performed for Alternatives 1, 2 and 3.

Below is a brief summary of results from the groundwater model report:

- The calibrated steady-state groundwater flow model developed for the site adequately represents flow conditions at the FMC Plant OU, as illustrated by the simulated potentiometric surface contour map and the calibration statistics presented in the model report.

- Plume matching results indicate that the parameters selected for both the groundwater flow and contaminant transport models were reasonable and provided an acceptable match between observed and predicted plume configurations. Overall, the calibrated transport model was most sensitive to changes in sorption coefficients and relatively insensitive to changes in dispersivity and porosity.

- The selected groundwater remedy (Alternative 2 in the model report) requires hydraulic containment of contaminated groundwater at the FMC Plant Site boundary. Many well configurations (alignment and number of wells) and extraction rates were tested, until an optimal configuration was found that minimized extraction rates while still completely capturing on-site contaminated groundwater.

2.3 SELECTED GROUNDWATER REMEDIAL ACTION MODEL RESULTS

The objective of the groundwater remedy selected in the IROD and required under the UAO (Model Groundwater Alternative 2) is to contain contaminated groundwater so that it does not migrate outside the FMC OU boundary. Many well configurations (alignment and number of wells) and extraction rates were modeled, until an optimal configuration was found that minimized extraction rates while still completely capturing on-site contaminated groundwater. Based on the modeling, the final extraction well system is expected to consist of five wells (depths will be range from approximately 120 feet bgs in the western portion of the extraction area to 140 feet bgs in the eastern portion) along the northern FMC Plant Site boundary, with a total extraction rate of 530 gpm. Containment was assessed by placing MODPATH particles within the footprint of the arsenic plume (largest plume) in the three uppermost layers and tracking them forward**.** Figure 1-3 presents the extraction well alignment and particle tracking showing containment of on-site contaminated groundwater for Alternative 2. This simulation also included infiltration of 440 gpm (the estimated infiltration rate for Alternative 2B presented in Appendix C of the Groundwater Model Report; MWH 2010b) to the western undeveloped area of the FMC OU to simulate the disposal of treated, extracted groundwater to a percolation/evaporation pond upgradient (west) of the groundwater contamination.

3.0 HYDROGEOLOGIC STUDY DESIGN

This section presents a description of the main components of the Hydrogeologic Study. The QAPP for this study and the groundwater sampling procedures are contained in Section 4. Field procedures for the installation of the extraction wells and piezometers and aquifer (pump) tests are contained in Appendices A and B, respectively. Standard operating procedures (SOPs) relevant to the field activities to implement this work plan are contained in Appendix D. The SOPs provided were previously developed for the supplemental remedial investigation for the FMC OU and were modified as needed for the RD field studies.

3.1 PRELIMINARY HYDROGEOLOGIC STUDY DESIGN

This section provides a discussion of the preliminary (Phase I) design of extraction wells and piezometers, including installation, construction, and testing. Design of the HCS including additional extraction wells (a total five based on preliminary modeling), a control/treatment building, and a discharge pipeline to the City of Pocatello POTW (Option A) or on-site infiltration gallery (Option B) will be presented in the RD upon completion of test analyses.

Groundwater model results indicate that installation of five groundwater extraction wells at a spacing of approximately 350 to 500 feet will create hydraulic containment and prevent further migration of the contaminated groundwater plume beyond the FMC Site northern boundary. The approximate locations (final locations to be determined in the field) of the extraction wells and piezometers proposed for this study are shown on Figure 3-1. Extraction wells EW-01, -02 and 03 are located at the western three (3) locations of the preliminary groundwater extraction system design of five (5) extraction wells along the northeast FMC plant property. The eastern two (2) extraction wells from the preliminary design are shown on Figure 3-1 as modeled extraction wells.

The western three (3) wells were selected for this study because, based on the groundwater model, these wells are predicted to capture the majority of the groundwater flow from beneath the FMC plant site and all the flow from the western ponds and central plant areas. Therefore, confirming the hydrogeology and aquifer characteristics at the western extraction wells is considered more critical to finalizing the overall groundwater extraction system than the eastern well locations that are modeled to intercept relatively low groundwater flow from the joint fenceline area. In addition, by including the “center” extraction well (based on the preliminary design), the updated groundwater model can be used to further refine the location(s) and designed extraction rate of well(s) toward the eastern plant property line to capture flow from the joint fenceline area. The design of the extraction wells and piezometers are described below.

3.1.1 Extraction Wells

Each extraction well will be constructed in a 12-inch diameter borehole drilled to approximately 120 feet bgs (the approximate depth of the bottom of the shallow aquifer zone and the top of the AFLB aquitard), actual depths of each well will likely vary. The intent of the extraction wells is to provide control (i.e., vertical and horizontal) of COC-impacted groundwater. Each extraction well will be constructed using six-inch diameter well material (i.e., well screen and casing). Also, a one-inch diameter piezometer will be co-installed (nested) within the 12-inch borehole, adjacent to the six-inch extraction well material (Figure 3-2).

The boreholes will likely be advanced using a casing advance drilling method that will be specified by the selected drilling subcontractor. Potential methodologies include roto-sonic, triple-wall air-percussion, or ARCH drilling. The extraction wells will consist of six-inch stainless steel wire-wrapped screen extending approximately 30-40 feet above the bottom of the borehole, with six-inch diameter, schedule 80 PVC casing extending from the top of the screen to the ground surface (refer to Figure 3-1). Stainless steel well screen and PVC pipe were selected because of their very low corrosion rates and dielectric compatibility. The sand pack around the extraction well screen will be selected based on screen slot size and lithology, and will consist of a silica sand pack that will prevent the migration of fine soil particles into the well. For the purposes of this preliminary design, it is assumed that 10/20 mesh sand will be used for the filter pack and will extend a minimum of five feet above the well screen. Above this will be a minimum five-foot thick bentonite seal and Portland Type A cement/bentonite grout seal to within eight feet of the ground surface. The area above the concrete seal will be completed with native fill to allow for future installation of the remaining wellhead completion hardware (e.g., power conduit, transmission piping, valves, gauges, etc.). The wells will be constructed following the procedures described in Appendix A.

To facilitate the initial aquifer tests, the top of the well will be temporarily finished with a PVC flanged end and a blind flange cover that can be padlocked for security. Following aquifer tests, this temporary completion will be replaced with a concrete collar, lockable steel protective casing and barriers to protect the wellheads.

3.1.2 Extraction Well Co-Installed Piezometers

Each six-inch diameter extraction well will have a one-inch diameter internal piezometer co-installed within the boring to allow the system operator to determine the water level within the well using a pressure transducer. The internal piezometers will have the same screen length and slot size as the extraction well screen (refer to Figure 3-1). Because each piezometer only needs to be large enough to accommodate a dedicated pressure transducer or a ¾-inch diameter water-level probe, it will be constructed of one-inch diameter, schedule 40 PVC casing. The top of the piezometer will be temporarily finished with a lockable watertight cap for security until final extraction well construction is completed.

3.1.3 Extraction Well Surface Completions

A protective metallic casing will be placed over each extraction well. In addition, each extraction well will have an appropriate number of barriers (e.g., Jersey barriers) to protect the wellheads. Each well and protective casing will be constructed to protrude above the ground surface, approximately 24 and 30 inches respectively. Each extraction well will be finished by placing soil around the well and sloped away from the wellhead to prevent surface water from ponding near the well.

3.2 GROUNDWATER PIEZOMETERS

In addition to the piezometers installed at each extraction well (i.e., within the same borehole), independent piezometers will be installed to monitor water levels in the immediate vicinity (within approximately 50- 300 feet) of the HCS extraction wells (Figure 3-1). These piezometers will be installed as the extraction wells are installed. As part of Phase I for the aquifer test and hydraulic containment test, six piezometers will be installed adjacent to the first three extraction wells and used to measure drawdown during the aquifer test and hydraulic containment test (Figure 1-3). Data from these locations will be used to determine hydraulic parameters of the aquifer including hydraulic conductivity, transmissivity, storativity, and specific yield. The piezometer arrangement will allow for the use of distance-drawdown methods as well as time-drawdown methods in the determination of these parameters. Furthermore, the arrangement will allow for delineation of anisotropy and heterogeneities within the subsurface soil strata and aquifer. Water-level data recorded during the hydraulic containment test will assist in siting additional piezometer pairs for design of the HCS system.

3.2.1 Field Procedures

The SOPs for installing extraction wells and piezometers including associated surface completion, development, and soil sampling and classification are presented in Appendix A. In addition, associated field forms that will be used for well installation are included in Appendix A.

3.3 AQUIFER TESTING NETWORK AND PROCEDURES

Variable pumping rate step-drawdown tests (i.e., six-hour step-tests, consisting of three two-hour steps) will be performed at each of the three Phase I extraction wells to determine well specific capacity and optimal pumping rates for each well. A 24-hour constant rate aquifer test will be performed on the western extraction well to determine aquifer hydraulic parameters. All three extraction wells will then be pumped simultaneously for a 72-hour hydraulic containment test.

The procedures for performing the step-tests, the constant rate pumping, and hydraulic containment test are outlined in Appendix B. Certain of the existing monitoring wells (listed in Table 3-1) will be used to monitor groundwater elevations during the pumping tests.

During the over 20 years of groundwater monitoring at the FMC OU, including sampling from approximately 125 monitoring wells at the FMC OU, over 4,500 samples and over 50,000 individual analytical results, no groundwater sample result has ever exceeded the threshold values for RCRA characteristic waste. The extracted groundwater from the aquifer testing will be managed and characterized as described in SOP 4 (Investigation Derived Waste) contained in Appendix D. As described in greater detail in SOP 4, the pump test purge water will be loaded into water trucks for dust control on the site. For dust control, the approximately 1.5 million gallons of water that will be pumped over an approximately one week period during the aquifer testing would represent a total of about 0.014 inches (or about 0.003 inches per day) of water spread over about a 340 acre area of the plant site (site-wide roadways and areas within RA-A).

3.4 AQUIFER TESTING ANALYSIS AND MODEL UPDATE

Data collected during the hydraulic containment testing will be used to develop hydrologic characteristics of the aquifer in the vicinity of the extraction wells. Water level measurements collected from the Phase I extraction wells, nearby piezometers, and more distant monitoring wells, will be imported into industry standard analytical software (e.g., AQTESOLV®) for analysis. Several different analytical methods (analytical methods may include Cooper-Jacob, Theis, Distance-Drawdown, and others) will be utilized to derive transmissivity, hydraulic conductivity and storage coefficients for the aquifer. Based on the results of the aquifer testing analysis, the capture zone will be evaluated using an analytical model for prediction of long-term performance of the extraction wells as part of the HCS.

Geologic, hydrogeologic and aquifer characteristics derived from the Phase I extraction well installation and aquifer testing (and analysis described above) will subsequently be used to update/refine the existing numerical groundwater flow model of the site. The numerical model will be calibrated to the observed performance of the aquifer during the 24- and 72-hour hydraulic containment test. Calibration of the model in the vicinity of the extraction wells may require grid refinement in order to simulate the measured groundwater drawdown more precisely. The revised numerical model will then be used to assess the potential long-term (100-year) performance (drawdown, hydraulic gradient, and flow net) of the initial three extraction wells. Results from these simulations will be used to predict if the three extraction wells are expected to meet the performance objectives of the HCS design. If the additional two (2) eastern extraction wells (or additional well[s]) are predicted to be necessary, the model results will be used to assist in selecting the appropriate locations of any additional extraction wells predicted to meet the performance objectives of the HCS. Additional simulations may also be performed to assess and optimize the pumping distribution among the extraction wells to improve the design of the HCS.

3.5 GROUNDWATER MONITORING AND SAMPLING AND ANALYSIS DURING AQUIFER TESTING

3.5.1 Water Level Measurements

Water level measurements will be collected from select piezometers and monitoring wells during the hydrogeologic study. Table 3-1 and Figure 1-3 provide a description of the piezometers and monitoring wells to be used to collect water level data during the tests. The measurement frequency and monitoring method (i.e., hand measurement or transducer) used at each monitoring point will vary, based on distance from the pumping well. Specifics on measurement frequency and method are provided in Appendix B.

3.5.2 Groundwater Sample Collection

Discrete time-composite and bulk groundwater samples will be collected from the installed extraction wells during the hydrogeologic test. Groundwater samples will be collected from each extraction well via an inline sample port installed in the discharge line. Table 3-2 provides a description of the HCS baseline effluent analytes, analytical test methods, reporting limits, and the precision and accuracy required to refine the expected average extracted groundwater quality to further evaluate the disposal method (i.e., disposal at the Pocatello POTW and/or on-site treatment) during design. Bulk groundwater samples (multiple 5-gallon containers) will also be collected during the aquifer (pump) tests. The bulk samples will be retained for potential utilization by third-party vendors for bench-top treatment testing in the event that an on-site treatment facility is required. Groundwater samples for chemical analysis and bulk bench-scale treatability study will be collected, as applicable, from each extraction well and as a composite of the HCS as follows:

- Six-hour step-test (discrete samples from each extraction well)
  - Start of six hour step test (approximately one hour after start of step one)
  - End of step three (prior to pump shut-down)
- 72-hour pump test (composite and bulk samples)
  - Start of 72-hour pump test (approximately one hour after start)
  - End of 36-hour period
  - End of pump test (72-hour period)

The groundwater sampling program is summarized on Table 3-3. Groundwater sample field and laboratory analytical procedures are described in Section 4.

Table 3-1

SUMMARY OF PIEZOMETRIC SURFACE ELEVATION MEASUREMENTS
Extraction Zone Hydrogeologic Characterization Study for the FMC OU
(Page 1 of 2)

Location Identification Number	Top of screen elevation (ft msl)	Bottom of screen elevation (ft msl)	Baseline piezometric surface elevation (ft msl)	0-20 minute piezometric surface elevation (ft msl)	20-40 minute piezometric surface elevation (ft msl)	40-60 minute piezometric surface elevation (ft msl)	2-12 hour piezometric surface elevation (ft msl)	greater than 24 hour piezometric surface elevation (ft msl)
EW-1	--	--	X	X	X	X	X	X
EW-2	--	--	X	X	X	X	X	X
EW-3	--	--	X	X	X	X	X	X
PZ-01	--	--	X	X	X	X	X	X
PZ-02	--	--	X	X	X	X	X	X
PZ-03	--	--	X	X	X	X	X	X
PZ-04	--	--	X	X	X	X	X	X
PZ-05	--	--	X	X	X	X	X	X
PZ-06	--	--	X	X	X	X	X	X
107	4294.5	4274.5	X	--	X	X	X	X
108	4382.7	4372.7	X	--	X	X	X	X
109	4312.2	4302.7	X	X	X	X	X	X
110	4364.3	4354.3	X	X	X	X	X	X
111	4374.0	4364.6	X	X	X	X	X	X
122	4372.4	4362.4	X	--	X	X	X	X
123	4375.5	4366.0	X	--	--	X	X	X
133	4259.7	4239.7	X	--	--	--	--	X
134	4374.5	4365.0	X	--	--	--	--	X
136	4365.1	4355.1	X	--	--	--	X	X
144	4288.1	4258.1	X	--	--	--	X	X
145	4347.0	4337.0	X	--	--	X	X	X
146	4367.9	4352.9	X	X	X	X	X	X
311*	4319.7	4309.7	X	--	--	--	X	X
312*	4360.8	4352.1	X	--	--	--	X	X
329*	4322.0	4312.0	X	--	--	--	X	X
331*	4378.0	4368.0	X	X	X	X	X	X
500	4323.6	4313.6	X	--	--	--	--	X
501	4376.5	4366.9	X	--	--	--	--	X
502	4375.1	4370.1	X	--	--	--	--	X
515	4379.1	4369.1	X	--	--	--	--	X
516	4375.2	4365.2	X	--	--	--	X	X
517	4377.1	4367.1	X	--	--	--	X	X
TW-9S	4373.0	4369.0	X	--	--	--	X	X
TW-2S	4373.0	4360.0	X	--	--	--	X	X
TW-2I	4285.0	4245.0	X	--	--	--	X	X
TW-2D	4178.0	4158.0	X	--	--	--	X	X
TW-5S	4378.0	4374.0	X	--	--	--	X	X

Table 3-1

SUMMARY OF PIEZOMETRIC SURFACE ELEVATION MEASUREMENTS
Extraction Zone Hydrogeologic Characterization Study for the FMC OU
(Page 2 of 2)

Location Identification Number	Top of screen elevation (ft msl)	Bottom of screen elevation (ft msl)	Baseline piezometric surface elevation (ft msl)	0-20 minute piezometric surface elevation (ft msl)	20-40 minute piezometric surface elevation (ft msl)	40-60 minute piezometric surface elevation (ft msl)	2-12 hour piezometric surface elevation (ft msl)	greater than 24 hour piezometric surface elevation (ft msl)
TW-5I	4341.0	4334.0	X	--	--	--	X	X
TW-5D	4202.0	4191.0	X	--	--	--	X	X
319*	4299.5	4279.5	X	--	--	--	--	X
320*	4384.2	4369.2	X	--	--	--	--	X
Old Pilot**	4371.0	4349.0	X	X	X	X	X	X
TW-11S	4377.0	4367.0	X	--	--	--	X	X
TW-11I	4299.0	4290.0	X	--	--	--	X	X
165 (control well)	4376.7	4366.7	X	--	--	--	X	X

ft msl means feet above mean sea level.
See Table B-1 for measurement frequency.
Highlighted locations will contain pressure transducers; hand-measurements will only be collected as backup as practicable.
* Wells are Simplot wells and may not be accessible during pump tests.
** Old pilot house well has a dedicated pump that may not allow access with a water level probe / transducer.

TABLE 3-2

GROUNDWATER FIELD MEASUREMENT AND LABORATORY ANALYSIS REQUIREMENTS
HYDROGEOLOGIC STUDY WORK PLAN FOR THE FMC OU

Parameter	Instrument / Method	Calibration	Calibration Frequency	Estimated Accuracy*	Average Concentration of Constituent in Groundwater (wells 110, 146, and TW-9S)	Groundwater Cleanup Standards (mg/l)***	Pocatello POTW Pretreatment Limits
Field Measurements							
Depth to Water (feet)	Electrical Water Probe Steel Tape	Reference to Steel Tape Reference to New Tape	Periodically Periodically	0.1 ft 0.01 ft	66.9	NA	NA
Specific Conductance (µmhos/cm)	Conductivity meter	Daily, single standard (typically 1413 µmhos/cm)	Daily	± 0.5% or 1 µmhos/cm	1521.7	NA	NA
Redox (mV)	ORP meter	Daily, using ORP buffer solution; solution temperature must also be recorded	Daily	± 20 mV	-100.0	NA	NA
Temperature (C)	Temperature meter	Factory calibration only	Factory only	0.15 °C	16.1	NA	NA
Nephelometric turbidity (NTU)	Turbidity meter	Daily, check against 2 known standards	Daily	± 2%	2.9	NA	NA
pH	pH meter	Daily, 2- or 3-point with standard buffers (4, 7, 10)	Daily	± 0.2 pH unit	7.01	6.5 to 8.5	6.0 to 10.0

Parameter	Analytical Method Number	Method Type	Reporting Limit (mg/l)	Estimated Accuracy*	Precision **	Average Concentration of Constituent in Groundwater (wells 110, 146, and TW-9S)	Groundwater Cleanup Standards (mg/l)***	Pocatello POTW Pretreatment Limits
WQP								
Fluoride	9056 (b) or 340.2 (c)	Ion Chromatography or Potentiometric, Ion Selective Electrode	0.1	75% - 125%	± 30%	0.30	4	32
Nitrate	9056 (b) or 353.2 (d)	Ion Chromatography or Colorimetric	0.1	75% - 125%	± 35%	6.63	10	NA
Total Phosphorus	6010B (a) or 365.2 (c)	Inductively Coupled Plasma / Mass Spectrometry or Colorimetric (ascorbic acid)	0.02	75% - 125%	± 30%	2.54	NA	7.0
Sulfate	9056 (b) or 375.4 (d)	Ion Chromatography or Turbidimetric	1	75% - 125%	± 30%	168	250	NA
Potassium	6010B (a)	Inductively Coupled Plasma Atomic Emission Spectrometry	0.1	75% - 125%	± 30%	43.4	NA	NA
Chloride	9056 (b) or 325.3 (c)	Ion Chromatography or Titrimetric	1	75% - 125%	± 30%	136.3	250	NA
Total Ammonia (NH3 + NH4 as N)	350.3 (d)	Potentiometric, Ion Selective Electrode	0.2	75% - 125%	± 30%	0.17	NA	NA

TABLE 3-2

GROUNDWATER FIELD MEASUREMENT AND LABORATORY ANALYSIS REQUIREMENTS
HYDROGEOLOGIC STUDY WORK PLAN FOR THE FMC OU

Parameter	Analytical Method Number	Method Type	Reporting Limit (mg/l)	Estimated Accuracy*	Precision **	Average Concentration of Constituent in Groundwater (wells 110, 146, and TW-9S)	Groundwater Cleanup Standards (mg/l)***	Pocatello POTW Pretreatment Limits
Metals (mg/l)								
Arsenic	6010B (a)	Inductively Coupled Plasma Atomic Emission Spectrometry	0.002	75% - 125%	± 30%	0.03	0.01	0.06
Cadmium	6010B (a)	Inductively Coupled Plasma Atomic Emission Spectrometry	0.002	75% - 125%	± 30%	<0.0005	0.01	0.2
Copper	6010B (a)	Inductively Coupled Plasma / Mass Spectrometry	0.01	75% - 125%	± 20%	0	1	0.5
Cyanide	335.4 (d)	Colorimetric	0.01	75% - 125%	± 30%	0.01	0.2	0.2
Lead	6010B (a)	Inductively Coupled Plasma / Mass Spectrometry	0.01	75% - 125%	± 20%	0	0.015	0.3
Mercury	SW 7470A (b)	Cold Vapor Atomic Absorbtion Spectrometry	0.0005	75% - 125%	± 20%	<0.0002	0.002	0.0006
Nickel	6010B (a)	Inductively Coupled Plasma / Mass Spectrometry	0.01	75% - 125%	± 20%	<0.04	0.73	1
Selenium	6010B (a)	Inductively Coupled Plasma Atomic Emission Spectrometry	0.0005	75% - 125%	± 30%	0.012	0.050	NA
Silver	6010B (a)	Inductively Coupled Plasma / Mass Spectrometry	0.01	75% - 125%	± 20%	<0.005	0.1	0.6
Zinc	6010B (a)	Inductively Coupled Plasma / Mass Spectrometry	0.02	75% - 125%	± 20%	0.001	71	1.2

(a) Analysis may also be performed using method 6020, both 6010 and 6020 from Test Methods for Evaluating Solid Waste, EPA SW–846, Third Edition, Update IIIB, as revised through 2002.

(b) Test Methods for Evaluating Solid Waste, EPA SW–846, Third Edition, Update IIIB, as revised through 2002.

(c) Methods for Chemical Analysis of Water and Wastes, EPA600/4–79–020, Revision, March 1983.

(d) Methods for the Determination of Inorganic Substances in Environmental Samples (EPA/600/R-93/100).

* percent recovery

** relative percent difference

*** Secondary Standard per National Secondary Drinking Water Regulations; MCL means Maximum Contaminant Level per National Primary Drinking Water Regulations; PRG means Preliminary Remedial Goal for Tap Water per EPA Region VI PRG Table (3/8/2008), except Lithium PRG is from the Region IX PRG Table (2004); TT Action Level means Treatment Technique action level per the National Primary Drinking Water Regulations.

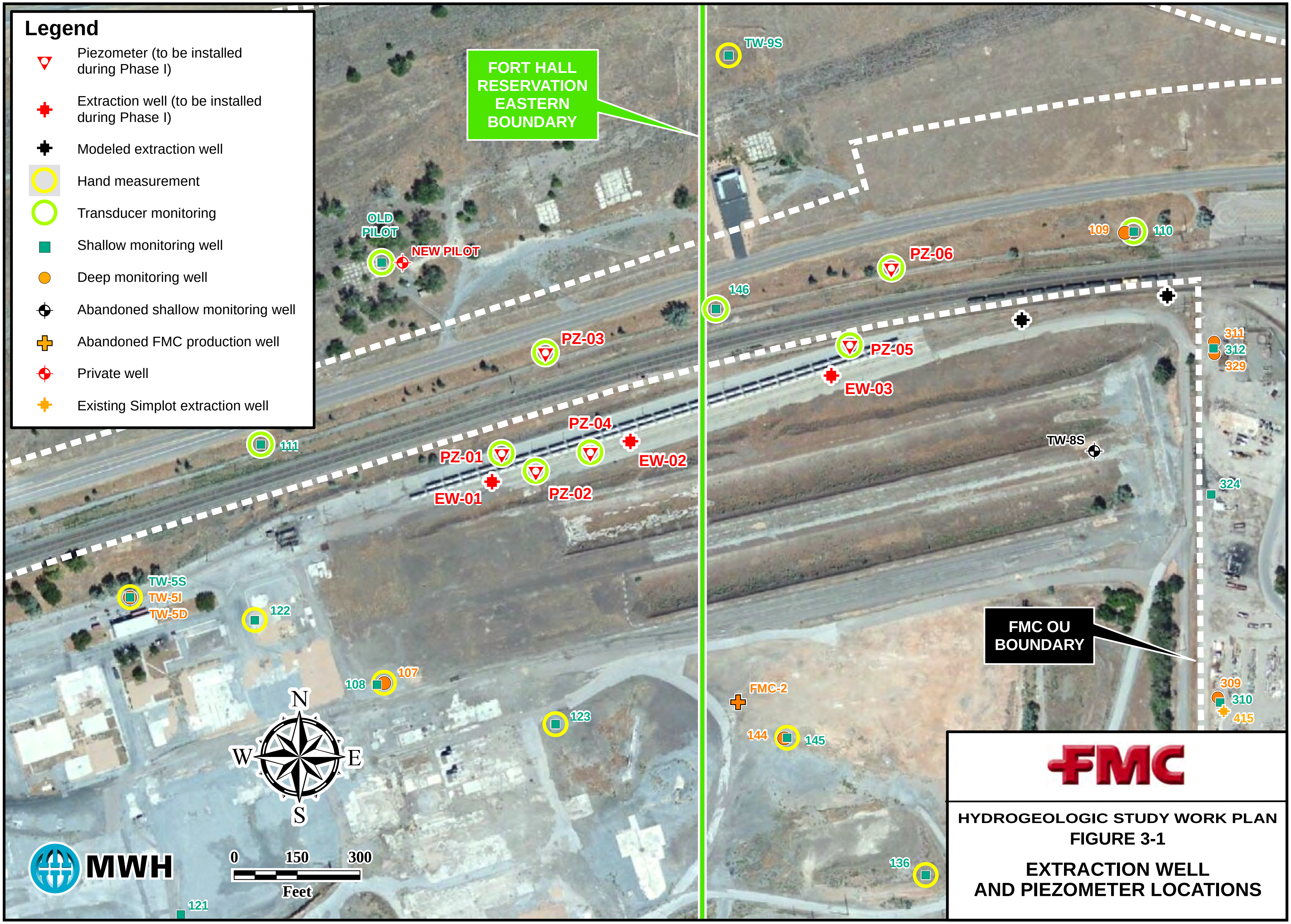
NA Not Applicable; no POTW standard

TABLE 3-3

SUMMARY OF GROUNDWATER SAMPLES
HYDROGEOLOGIC STUDY WORK PLAN FOR THE FMC OU

<table>
<tr><th rowspan="4">Well</th><th colspan="4">6-hour Step Test</th><th colspan="2">72-hour Containment Test</th></tr>
<tr><th rowspan="2">Primary Samples</th><th colspan="2">Field Quality Control Samples</th><th rowspan="3">Total</th><th rowspan="2">Composite Sample</th><th rowspan="2">Bulk Samples</th></tr>
<tr><th>Duplicate</th><th>MS / MSD</th></tr>
<tr><td>Analyses per Table 3-2</td><td>Analyses per Table 3-2</td><td>Analyses per Table 3-2</td><td>Analyses per Table 3-2</td><td>Hold for potential bench-top treatment testing</td></tr>
<tr><td>EW-01</td><td>2</td><td>1</td><td>0</td><td>3</td><td rowspan="3">1 flow-weighted composite</td><td rowspan="3">Five 5-gallon flow-weighted composites</td></tr>
<tr><td>EW-02</td><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>EW-03</td><td>2</td><td>0</td><td>1</td><td>3</td></tr>
<tr><td>Total</td><td>6</td><td>1</td><td>1</td><td>8</td><td>1</td><td>5</td></tr>
</table>

FILE: I:\projects\FMCidaho\FMC_Hydrogeologic Study WP\FIGURES\Fig 3-1_Extract Well and Piez Locs.mxd DATE: 15 July 2013

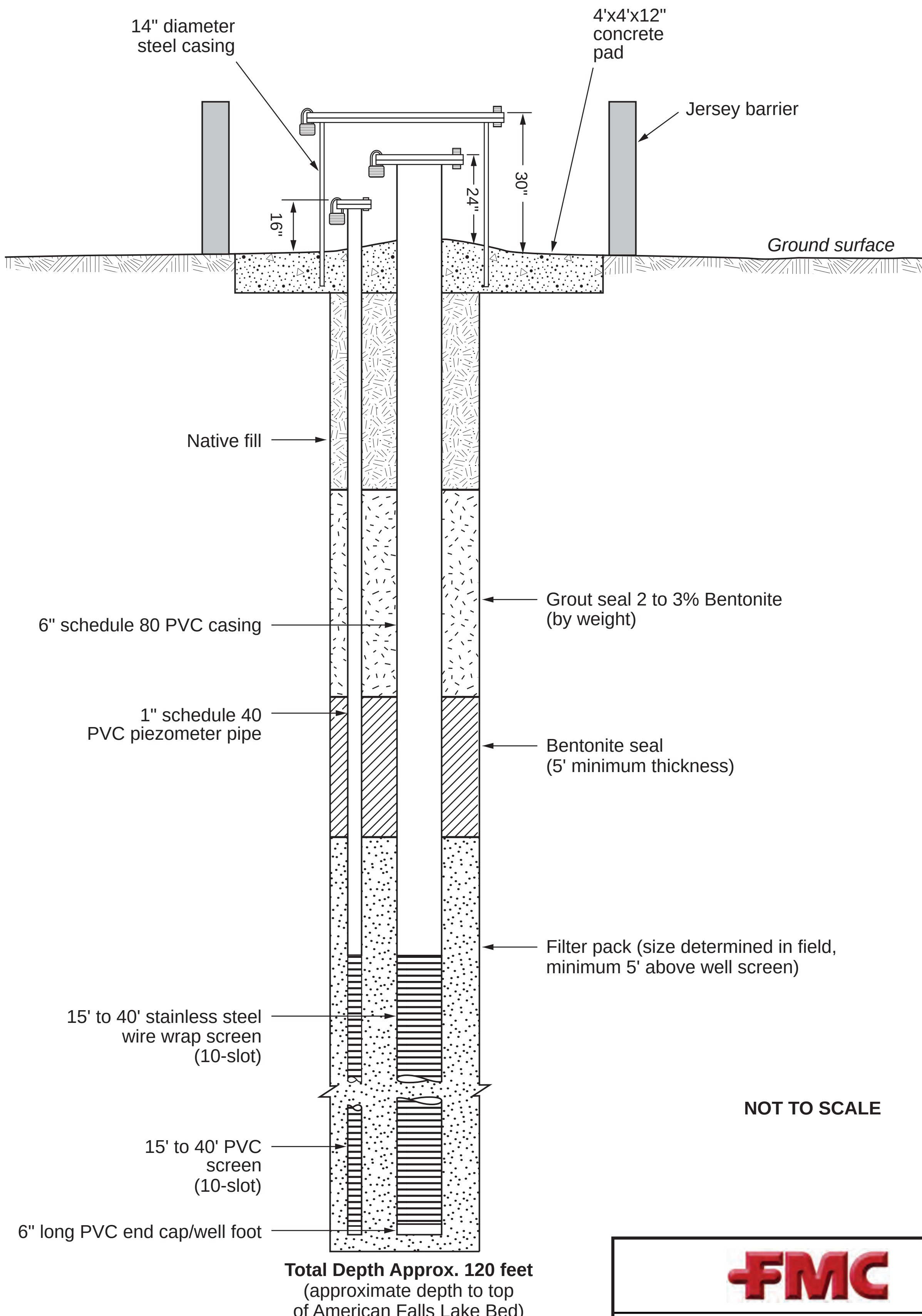


FMC

HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 3-1

EXTRACTION WELL AND PIEZOMETER LOCATIONS



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HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 3-2

GENERALIZED
EXTRACTION WELL DESIGN

FILE *Fig 3-2_Generalized Extraction Well Design_mod2.ai* DATE: *17 Oct 2013*

4.0 QAPP AND FSP

4.1 INTRODUCTION

This section presents the QAPP and the Field Sampling Plan (FSP) for the Hydrogeologic Study and includes:

- Project team and project organization;
- Data Quality Objectives (DQOs);
- Field measurement and sampling procedures
- Equipment calibration procedures
- Sample preservation and handling procedures; and,
- Personnel training.

4.2 PROJECT TEAM AND ORGANIZATION

The responsibility and authority of each team member in this project organization is presented below.

4.2.1 EPA Remedial Project Manager

The EPA is the lead agency governing the remediation of the FMC OU. The EPA issued the IROD and UAO, and is responsible for approving all plans and reports related to implementing the Selected Remedy, including the Hydrogeological Study. The EPA Remedial Project Manager is Mr. Kevin Rochlin.

4.2.2 FMC Project Coordinator

As the responsible party, FMC is implementing the Selected Remedy in accordance with the UAO. FMC has overall responsibility for procuring consultants and contractors to perform the work, budgeting and securing the necessary funds, and assuring that the requirements of the UAO are met. The FMC Remediation Director is Ms. Barbara Ritchie.

4.2.3 MWH Project Director

Mr. Marc Bowman is the MWH Project Director and main point of contact for MWH Americas, Inc., the Supervising Contractor. Mr. Bowman was the MWH Project Manager (PM) for the FMC Plant OU SRI/SFS and will have overall responsibility for successful completion of the RD and the Hydrogeological Study. He will be responsible for the contractual commitments and for ensuring that the necessary resources are dedicated to the project, will define/clarify the scope of work and objectives for each major activity, and will assure the technical, budget, and schedule requirements are met.

4.2.4 MWH RD Manager

Mr. Rob Hartman is the MWH RD Manager and will be responsible for day-to-day technical elements of the Hydrogeological Study. Mr. Hartman, along with the MWH Project Director, will be responsible for coordinating with the necessary agencies and authorities to identify any permit requirements associated with implementation of the remedy.

4.2.5 MWH Hydrogeological Manager

Mr. Jesse Stewart will serve as the MWH Hydrogeologic Manager and serve as the primary interface to the MWH Project Director and the RD Manager. He will be responsible for coordinating the necessary resources to accomplish the Study elements and to complete the Hydrogeological Study testing on schedule as well as providing construction quality assurance.

4.3 DATA QUALITY OBJECTIVES

During execution of the Hydrogeologic Study there are three types of data to be collected:

1. Qualitative / semi-quantitative observations associated with drilling the boreholes (e.g., lithologic logging), determination of the well screen interval and screen slot size, and development of the extraction wells and piezometers;

2. Physical measurements (e.g., groundwater elevations) associated with drilling the boreholes (e.g., depth of lithologic samples), construction of the extraction wells and piezometers (e.g., setting bottom of casing), and aquifer pumping tests; and,

3. Physical and chemical analyses of groundwater samples collected during drilling the boreholes for the extraction wells, during development of the extraction wells and piezometers, and during the aquifer testing from the extraction wells.

The Data Collection Quality Objectives for the Hydrogeological Study are presented in Table 4-1.

4.3.1 Extraction Well and Piezometer Installation

There is no "problem statement" associated with the installation of the extraction wells and piezometers during the execution of this Plan. Thus, no specific, numeric data quality objectives (DQOs) have been established. However, there will be numerous observation and measurements performed during drilling of the boreholes for the extraction wells that will be utilized to finalize well construction / completion details as summarized below:

Observation / Measurement during Drilling	Extraction Well Construction Element
Static water level in borehole	Top of screen will extend approximately 5 feet above static water level
Lithologic logging in saturated zone: soil types	Screened casing slot size
Groundwater chemistry profiling	Screen length and bottom of hole / well if SC < 500 umhos/cm and phosphate field analysis < 0.1 mg/l before encountering top of the AFLB
Lithologic logging: top of AFLB	Screen length and bottom of hole / well if SC > 500 umhos/cm and phosphate field analysis > 0.1 mg/l in sample at or above the top of the AFLB

As specified in Section A.2.3 of the Extraction Well and Piezometer Installation Field Procedures detailed in Appendix A, the screened casing slot size and screened interval for each extraction well will be selected based on stratigraphic interpretations and groundwater chemistry profiling during drilling activities and after consulting with the MWH Hydrogeological Manager. The use of qualified field personnel (geologists/hydrogeologists), adherence to the Extraction Well and Piezometer Installation Field Procedures detailed in Appendix A, and field documentation will assure the wells/piezometers will be installed properly and will meet the requirements for this hydrogeologic study and completing the design and ultimately the full-scale implementation of the HCS.

4.3.2 Aquifer Pump Test Physical Measurements

The pump test physical measurements that will be collected are direct measurements and there is no “problem statement” or “decisions” associated with the data. Thus, no specific, numeric data quality objectives (DQOs) have been established. As specified in the Procedures for Conducting

Step Drawdown Tests, Drawdown Tests, Constant Discharge Aquifer Tests and Multiple Well Containment (Appendix B) , manual water-level measurements shall be collected using electronic water-level indicators capable of measuring to 0.01-foot accuracy during all segments of the aquifer test. Electronic water-level indicators will be dedicated to specific wells during the test to avoid errors due to slight differences between indicators. Manual water-level measurements shall be collected as a back-up to water-levels measured using pressure transducers and data loggers.

4.3.3 Groundwater Samples - Field and Laboratory Analyses

Field analyses will be performed on groundwater samples collected during drilling the boreholes for the extraction wells, during development of the extraction wells and piezometers, and during the aquifer testing from the extraction wells.

The groundwater field parameters will be measured utilizing calibrated field meters with the calibration frequency and accuracy specified on Table 3-2. Note that during drilling the extraction wells the groundwater chemistry profiling samples will be field analyzed for the parameters listed on Table A.2.3-1. The field meters for those parameters will meet the calibration frequency and accuracy specified on Table 3-2 with the exception of phosphate. Phosphate will be field-analyzed using a Hach portable colorimetric phosphate test kit (Model PO-23 or comparable). The Model PO-23 has two (2) measurement concentration ranges of 0.1 to 5 mg/l and 1 to 50 mg/l which should be adequate for the range of expected groundwater phosphate concentrations at the extraction well locations. Hach does not specify a calibration method / frequency or precision/accuracy information for their portable phosphate test kits.

In addition to the field analyses, groundwater samples will be collected from the extraction wells during the aquifer (pump) testing for laboratory analyses. The groundwater samples from the extraction wells will be analyzed at a NELAP-accredited analytical laboratory for the parameters specified on Table 3-2. The acceptable level of uncertainty is included in Table 3-2 as accuracy and precision goals. Samples will be collected and handled as described in Section 4.4.2 below. The specified reporting limits are below the lower of the groundwater cleanup standard or Pocatello POTW Pretreatment Limit to assure the data are useable.

The laboratory analytical results for the groundwater samples from the extraction wells will be validated consistent with the Data Verification and Validation Protocol for FMC's groundwater monitoring programs (Appendix C of the Interim CERCLA Groundwater Monitoring Plan for the FMC OU [MWH, 2010c]). A Level III data verification will be performed on the sample results. Level III verification involves a review of all administrative documents, including field and laboratory chain-of-custody documents, sample preservation records, and sample preparation logs. For all precision and accuracy evaluations, laboratory summary information and forms will be evaluated for the individual laboratory methods.

4.4 SAMPLING/MEASUREMENT PROCEDURES

4.4.1 Extraction Well and Piezometer Installation Procedures

The methodologies and procedures for installation of the extraction wells and piezometers are presented in Appendix A.

4.4.2 Aquifer Test Procedures

The methodologies and procedures for performing the aquifer testing program are presented in Appendix B.

4.4.3 Groundwater Sampling Procedures

As described in Section 3, summarized on Table 3-3 and shown on Table 4-1, three types of groundwater samples will be collected during this study:

1. Discrete samples for laboratory analysis collected at the start (approximately one hour after the start) of the six-hour step drawdown test at each extraction well;
2. A composite sample for laboratory analysis that includes aliquots collected at the start (approximately one hour after the start), after 36 hours and at the end of the 72-hour multi-extraction well containment pump test; and
3. Composite ("bulk") samples that include aliquots collected at the start (approximately one hour after the start), after 36 hours and at the end of the 72-hour multi-extraction well containment pump test to be retained for potential bench / jar testing by water treatment equipment / supply vendors.

The procedures for collecting, labeling and handling these samples is described below.

4.4.3.1 Sample Designation

All samples collected will be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The station location will be described in the logbook as follows, in a manner consistent with the conventions used during the remedial investigation. A one-digit number will be used to indicate the year in which the sample was collected, for example "3" indicates a sample was collected in 2013. This digit will be followed by two others indicating the month in which the sample was collected, for example "03" indicates a sample was collected in March. Finally, additional digits or letters will identify the well from which the sample was collected. The location description, 403EW01 indicates a sample collected from Well EZ-01 in March 2014.

At a minimum, the sample labels will contain the following information:

- Facility name.
- Sample number.
- Date of collection.
- Time of collection.

- Analytical parameter.
- Method of preservation.

Samples collected for field QC will be identified by a three-digit or descriptive letter combination.

- Field Duplicate: The well number will be designated as “600.”

- Samples collected for laboratory QC will be identified on bottles and field paperwork using an A, B, or C designation as a suffix to the sample identifier code. These QC codes will be designated as follows:

    - A - Original unspiked sample
    - B - Matrix spike (MS)
    - C - Matrix spike duplicate (MSD)

4.4.3.2 Sample Collection

The discrete groundwater samples will be collected directly from the pump tubing (at each extraction well) into the appropriate sample containers, preserved as described below, and chilled and processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the discharge tubing to the sample container. As shown on Table 3-3, a duplicate sample will be collected during the collection of the 6-hour step test at well EZ-01 (during second sample near end of 6 hour test) and MS/MSD sample will be collected during the collection of the 6-hour step test at well EZ-03 (during second sample near end of 6 hour test).

The composite sample will initially be collected in an approximately 5-gallon pre-cleaned container. An aliquot from each extraction well will be collected at the time intervals specified above and on Table 4-1. The volume of the aliquot from each well will be in proportion to the pump rates set for each well during the multi-extraction well containment pump test. For example, if well EW-1 is pumping at 120 gpm, well EW-2 at 100 gpm and EW-3 at 80 gpm, then the aliquot volume from EW-1 and EW-3 will be 20 percent greater and lower, respectively than the aliquot from well EW-2. As nine (9) total aliquots will be collected in a 5-gallon container, the “base” aliquot volume will be about 0.5 gallons.

The composite groundwater sample will then be transferred into the appropriate sample containers, preserved as described below, and chilled and processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the 5-gallon composite collection container to the sample container.

The same procedure described for the initial collection of the composite sample into 5-gallon containers will be used to collect the bulk samples that will be retained. Approximately eight (8) bulk samples will be collected and retained.

For the discrete and composite samples to be submitted for laboratory analysis, a separate pre-cleaned container will be filled and used to measure the field parameters. A field pH meter with a combination electrode or equivalent will be used for pH measurement. A field conductivity meter will be used for specific conductance measurements. A nephelometer-type turbidimeter will be used for turbidity measurements. Temperature measurements will be performed using standard thermometers or equivalent temperature meters. A combined field meter or individual meters will be used for dissolved oxygen and ORP measurements. Combination instruments capable of measuring multiple parameters may also be used. All instruments will be calibrated in accordance with manufacturers' recommendations. The field parameter measurement, calibration and accuracy requirements are provide on Table 3-2.

The recommended sample containers and required sample preservation and holding times for the discrete and composite sample to be submitted for laboratory analysis are summarized in the inset table below.

Sample Preservation and Holding Time Requirements for Laboratory Analyses

Parameter	Recommended Container	Preservative	Maximum Holding Time
Water Quality (Cl^-, F^-, NO_3^-, and SO_4^{2-})	0.5-liter polyethylene bottle	Cool to 4°C	28 days
Metals (Ag, As, Cd, Cu, Hg, K, Pb, Ni, Se, Mn, B, V, Zn and Total phosphorus)	0.25-liter polyethylene bottles	HNO_3 to pH $\leq$ 2, Cool to 4°C	6 months; except Hg is 28 day hold time
Total Ammonia	0.5-liter polyethylene bottle	H_2SO_4 to pH $\leq$ 2; Cool to 4°C	28 days
Total cyanide	0.5-liter polyethylene bottle	NaOH to pH $\geq$ 12; Cool to 4°C	14 days

The sample designation, field parameters and number of containers / preservation for each of the samples to be submitted to the laboratory for analysis will be documented on a groundwater sampling field form (Appendix C).

4.4.3.3 Sample Handling

All sample containers will be pre-cleaned. Preservatives, if required, will be added to the containers prior to shipment of the sample containers from the laboratory (pre-preserved) or added to the samples(s) in the field as needed to meet sample preservation requirements.

All sample containers for submittal for laboratory analysis will be placed in a strong, rigid-walled shipping container such as a heavy plastic cooler. The following outlines the packaging procedures that will be followed.

1. When ice is used, secure the drain plug of the cooler with tape to prevent melting ice from leaking out of the cooler.
2. Line the cooler with bubble wrap, as needed, to prevent breakage during shipment.
3. Check screw caps for tightness and, if not full, mark the sample volume level of liquid samples on the outside of their sample bottles with indelible ink.
4. Custody-seal all container tops.
5. Affix sample labels onto the containers and write sample number on container with indelible ink.
6. Wrap all glass sample containers in bubble wrap to prevent breakage.

All samples will be placed in coolers with the appropriate chain-of-custody form. All forms will be enclosed in a large plastic bag and affixed to the underside of the cooler lid. Empty space in the cooler will be filled with bubble wrap to prevent movement and breakage during shipment. Ice used to cool samples will be placed on top and around the samples to chill them to the correct temperature. Both samples and ice will be double-bagged in large plastic bags. Each ice chest will be securely taped shut with strapping tape; and custody seals will be affixed to the front and back of each cooler.

The retained bulk groundwater samples will be labeled as described above and stored at a secure location.

4.5 PERSONNEL TRAINING

All personnel directly involved with the Hydrogeological Study will be provided with a copy of this Plan. Personnel will be trained in the requirements specified herein and provided ample time to read and become familiar with these requirements prior to beginning data collection activities. All onsite personnel shall conform to the MWH health and safety plans and the FMC *Site-Wide Health and Safety Plan* (FMC 2013).

Table 4-1

Data Collection Quality Objectives
Groundwater Extraction Zone Hydrogeologic Study Work Plan for the FMC OU

#	DQO Step	Extraction Well and Piezometer Installation	HCS Model Prediction Capture Zone Determination	Establish Expected Average HCS Effluent Quality to Refine Evaluation of Disposal Options
1	State the problem	New extraction wells and piezometers need to be installed / constructed properly and will meet the requirements for the HCS.	Verify Model Predictions and determine the alignment and layout for the final design of the full-scale HCS to capture contaminated groundwater before it migrates beyond the FMC Plant Site.	Establish expected average effluent quality to refine evaluation of management/disposal options (i.e., discharge to the Pocatello POTW or on-site treatment and discharge to percolation basin(s)).
2	Identify the decision	Finalize well construction / completion details.	Define hydrogeologic conditions in the extraction well zone identified by the groundwater model.	Expected average HCS effluent quality and total flow are needed to evaluate and determine if discharge to the POTW is viable, and to finalize design for the management/disposal option.
3	Identify inputs to the decision	Numerous observation and measurements performed during drilling of the boreholes for the extraction wells including: • Geologic / lithologic logging – soil types • Static water level in borehole • Groundwater chemistry profiling results – groundwater samples will be collected and filed analyzed for approximately every 10 feet of drill depth within the saturated zone (for extraction wells). Field analyses per Table A.2.3-1 of Appendix A.	Groundwater elevation (water level) data collected from select locations at and near the extraction area (see Table 3-1). Water levels will be measured to an accuracy of 0.01 foot. Groundwater pump test results will be utilized to update the groundwater model.	Groundwater samples for chemical analysis and bulk bench-scale treatability study will be collected, as applicable, from each extraction well and as an composite of the HCS as follows: **Six-hour step-test (discrete samples from each extraction well)** • Start of six hour step test (approximately one hour after start of step one). • End of step three (prior to pump shut-down) **72-hour pump test (composite and bulk samples)** • Start of 72-hour pump test (approximately one hour after start) • End of t 36-hour period • End of pump test (72-hour period)
4	Define the study boundaries	Vertical extent of borehole advanced to construct wells.	Approximate northeast boundary of the FMC Plant OU.	Groundwater in the impacted shallow aquifer zone at the northeast boundary of the FMC Plan OU.

Table 4-1

Data Collection Quality Objectives
Groundwater Extraction Zone Hydrogeologic Study Work Plan for the FMC OU

#	DQO Step		HCS Model Prediction Capture Zone Determination	Establish Expected Average HCS Effluent Quality to Refine Evaluation of Disposal Options
5	Develop a decision rule	Screened casing slot size will be determined by saturated zone soil types (grain size). Top of screen will extend approximately 5 feet above static water level. Screen length and bottom of hole based on groundwater chemistry profile: • If SC < 500 umhos/cm and phosphate field analysis < 0.1 mg/l before encountering top of the AFLB, bottom of hole / screen set above American Falls Lake Bed (AFLB) deposits; or • If SC > 500 umhos/cm and phosphate field analysis > 0.1 mg/l in sample at or above the top of the AFLB, bottom of hole / screen set at top of AFLB.	A groundwater model update will be used to determine whether the full-scale HCS can provide long-term groundwater capture at the FMC Site boundary.	The results will be used to refine evaluation of management/disposal options.
6	Specify limits on decision errors	Not applicable.	Based on previous modeling efforts (mean absolute error), differences between simulated and observed head conditions should be less than or equal to an absolute value of 1.1 feet across the model domain.	Not applicable.
7	Optimize the design for obtaining data	The borings and well construction will be conducted as described in this Plan.	Data will be collected as described in Section 3.0 and Appendix B of this Plan.	The field hydrogeologic studies and data evaluation activities will be conducted as described in this Plan.

5.0 DATA REDUCTION, REVIEW AND REPORTING

5.1 DATA REDUCTION

Data collection for the Hydrogeologic Study will be performed in the field and analytical laboratory. Field data will be used as reported from properly calibrated water level meters and pressure transducers. Analytical data will be provided by the analytical laboratory.

5.2 DATA REVIEW, PERFORMANCE AUDITS AND CORRECTIVE ACTIONS

Prior to use, the MWH RD Manager or designee will review and assess the quality of field data. The data will be reviewed to assess whether the procedures specified in this Work Plan, including the QAPP and FSP, were followed and to identify inconsistencies and/or anomalous values. Any inconsistencies will be resolved immediately, if possible, by seeking clarification from those personnel responsible for data collection. At a minimum, the information contained in field logs/notes, field-sampling forms, instrument outputs, as applicable, will be included in the review process. All changes or corrections to this field documentation will also be reviewed. A narrative will be prepared that describes any deviations from the procedures, explains any qualifications regarding the data quality, and describes any significant problem identified during the review process.

As the field portion of the hydrogeologic study is expected to be completed within three to five weeks, construction quality control measurements will be field audited at least twice during the field effort.

5.3 DOCUMENTATION AND REPORTING

All data collected in direct support of this hydrogeologic study will be retained by FMC and/or its contractors consistent with the records retention requirements under the UAO. All data collected in direct support of this extraction area hydrogeologic characterization study will be reported to EPA in a report entitled *Hydrogeologic Study Report* to be provided within 60 days of completion of the field work or receipt of final validated laboratory analytical reports, whichever is later. This will allow time for data interpretation and processing as well as an update to the groundwater model.

6.0 HEALTH AND SAFETY PLAN

The FMC Plant OU is covered by the *Site-Wide Health and Safety Plan* ([SWHASP], FMC 2013). The SWHASP provides the Site health and safety organization, specific Site hazards, Site controls, Site evacuation procedures, Site PPE requirements, general health and safety procedures, and emergency procedures. In addition, the SWHASP requires that all Contractors working on the Site will develop their own action-specific Health and Safety Plan (HASP) which will incorporate the general requirements specified in the SWHASP. Each Contractor's action-specific HASPs must provide specific health and safety requirements that are pertinent to the anticipated activities during that action.

Per the requirements of UAO Section IX, Paragraph 30. a., FMC will submit the most recent version of the SWHASP under a separate transmittal. Copies of the SWHASP and all Contractor action-specific HASPs will be maintained on Site during actions performed under this Work Plan.

7.0 DELIVERABLES AND SCHEDULE

In addition to this Plan and the SWHASP (as described in Section 6.0), a report entitled *Hydrogeologic Study Report* will be provided within 60 days of completion of the field work or receipt of final validated laboratory analytical reports, whichever is later.

The overall hydrogeologic study project schedule is as follows:

Project Activity	**Schedule**
Submittal of the *Site-Wide Health and Safety Plan*	Submitted July 15, 2013; Updated version submitted December 27, 2013
Submittal of *Hydrogeologic Study Work Plan*	Draft submitted July 15, 2013; this revised version submitted on or before January 10, 2014.
Mobilize for implementation of field work	Targeting mid-March 2014 pending final approval of the *Hydrogeologic Study Work Plan.*
Complete field work	75 days after mobilization / implementation of field work.
Submittal of the *Hydrogeologic Study Report*	60 days after completion of field work or receipt of final validated laboratory analytical reports, whichever is later.

8.0 REFERENCES

Bechtel, 1996. Remedial Investigation Report for the Eastern Michaud Flat Site. Bechtel Environmental, Inc. Draft issued September 1995 and revised August 1996.

EPA, 2012. Interim Amendment to the Record of Decision for the EMF Superfund Site - FMC Operable Unit - Pocatello, Idaho, September 27, 2012.

EPA, 2013. Unilateral Administrative Order for Remedial Design and Remedial Action, EPA Docket No. CERCLA-10-2013-0116, June 10, 2013.

FMC, 2013. Site-Wide Health and Safety Plan, July 2013; *RCRA Pond Area Work Rules Updated 12/17/13*.

Houser, 1992. Quaternary stratigraphy of an area northeast of American Falls Reservoir, eastern Snake River Plan, Idaho, Link, P. K., et al., eds., Regional Geology of Eastern Idaho and Western Wyoming, *Geological Society of America Memoir*, Vol. 179, pp. 269-288.

Jacobson, 1984. "Hydrogeology of Eastern Michaud Flats, Fort Hall Indian Reservation, Idaho," U.S. Geological Survey Open-File Report 84-4201, Boise, Idaho.

MWH, 2009a. Groundwater Current Conditions Report for the FMC Plant Operable Unit, June 2009 - Final.

MWH, 2009b. Supplemental Remedial Investigation Report for the FMC Plant OU, May 2009.

MWH, 2010a. Supplemental Feasibility Study Report for the FMC Plant Operable Unit, July 2010.

MWH, 2010b. Groundwater Model Report for the FMC Plant Operable Unit, July 2010 (Appendix E of the SFS Report).

MWH, 2010c. Interim CERCLA Groundwater Monitoring Plan for the FMC Operable Unit, July 2010.

APPENDIX A

EXTRACTION WELL AND PIEZOMETER INSTALLATION FIELD PROCEDURES

A.1 INTRODUCTION

This appendix describes and outlines field procedures for the installation, development, topographic survey, and groundwater elevation measurements of extraction wells, monitoring wells/piezometers for the FMC OU Hydrogeologic Study in support of the FMC OU Boundary Hydraulic Containment System (HCS).

A.2 GENERAL CONSIDERATIONS FOR WELL INSTALLATION

A.2.1 Underground Utility Locating and Digging Permits

Subsurface locations will be cleared by FMC as specified in SOP 1 provided in Appendix D. If any underground utilities are determined to be present at a proposed location, the location will be moved to the nearest area clear of utilities.

A.2.2 Well and Piezometer Designations

For the purposes of this Plan, the extraction wells, monitoring wells, and piezometers are numbered sequentially using “EW” to indicate an extraction well, “and “PZ” to indicate a piezometer (e.g., EW1, EW2 and PZ1, PZ2). As the wells and piezometers are installed during the phased process, they will be given designations that conform to FMC OU guidelines.

A.2.3 Soil Sample Collection and Groundwater Chemistry Profiling Procedures

During drilling activities, soil samples for stratigraphic logging will be collected from the borehole prior to well installation. Soil samples will be collected using a split-spoon sampler or from soil cores (e.g., sonic drill cores). As necessary, a sample catcher will be placed at the end of the sampler so that unconsolidated soils are not lost as the sample device is retrieved from the borehole.

In the event that the HCS extraction wells and piezometers are installed using roto-sonic drilling methods, soil cores for stratigraphic logging will be collected continuously throughout the length of the borehole. However, if the extraction wells and piezometers installation is performed using other drill methods (i.e., air-rotary, etc.,) soil samples will be collected using a split-spoon sampler at 5-foot centers above the water table, and then continuously from approximately 5 feet above the saturated zone to the bottom of the boring. Split-spoon, soil samples for piezometers installed will be collected following the same procedures as for the extraction wells. The screened casing slot size and interval will be selected based on the static water level in the borehole, stratigraphic interpretations and groundwater chemistry profiling during drilling activities and after consulting with the MWH Hydrogeological Manager.

Stratigraphic logging will be performed at each well and piezometer location according to the Unified Soil Classification System (USCS). The USCS soil classification is based on grain size, degree of grading, stiffness, plasticity, and density. In addition, the soil description will also include Munsell color (wet), soil particle angularity, and moisture content), if present. All stratigraphic data will be recorded on the Extraction Well/Piezometer Boring Log Form (included in the field forms the end of Appendix A).

Field analyses of groundwater samples for indicator constituents of site-affected groundwater will be performed during drilling of the extraction wells. The field analyses will be performed to supplement the stratigraphic interpretations for the selection of screen intervals.

Groundwater samples will be collected from the saturated zone during drilling. Since the roto-sonic, triple-wall air-percussion, or ARCH drilling methods will maintain an open borehole, groundwater encountered during drilling is most likely to originate in the zone between the end of the advance casing and the drill bit. A submersible pump or hydropunch groundwater sampling tip will be placed near the tip of the advance casing and the groundwater will be pumped to the surface for field analysis. Groundwater quality parameters (pH, temperature, and specific conductance) will be monitored during pumping until a representative sample can be obtained. Once representative conditions are observed, a sample of the discharge will be collected and analyzed in the field for the parameters listed in Table A.2.3-1. One sample will be collected and analyzed for approximately every 10 feet of drill depth within the saturated zone. The results will be used in conjunction with lithologic logging observations to select the interval for placement of the well screen.

Table A.2.3-1: Groundwater analyses conducted during drilling.

Analytical Parameter	Method
pH	Multi-probe field meter
Specific Conductance	Multi-probe field meter
Redox	Multi-probe field meter
Temperature	Multi-probe field meter
Nephelometric turbidity (NTU)	Turbidity meter
Phosphate	HACH portable colorimeter

A.2.4 Decontamination Procedures

All down-hole drilling and sampling equipment will be decontaminated prior to use at each borehole location in accordance with SOP 2 provided in Appendix D. After decontamination, down-hole equipment will be kept off the ground and stored on a clean surface (e.g., plastic) until it is used. All decontamination fluids will be disposed of according to the protocols established in SOP 4 provided in Appendix D.

A.2.5 Documentation

Field activities associated with extraction well and piezometer drilling, soil sampling, construction, completion, and development will be recorded on field forms included as an Attachment to this Appendix. The MWH on-site representative will maintain a field logbook. The field logbook will be a weather resistant, bound, survey-type book, with non-removable pages. Information to be entered in the logbook typically will include the name and location of the job, personnel on site, name and address of the field contact person, the date(s) the borehole was started and completed, weather conditions, sampling methodology, sample depths, decontamination procedures, and any other observations that may be relevant to the field program.

A.2.6 Well and Piezometer Development Procedures

The extraction wells and piezometers will be developed no sooner than 48-hours after grouting and construction are completed. The extraction wells and piezometers will be developed using a combination of a surge block and bailer and either a portable centrifugal pump, a submersible pump, or airlift pump. The depth to groundwater and the total depth of the well will be measured with an electric water-level indicator prior to and immediately after development.

During extraction well and piezometer development, water quality parameters such as pH, specific conductivity, temperature, and turbidity will be monitored. These parameters will be measured with a portable water-quality meter. The parameters will be measured at the beginning of well development and after the evacuation of each borehole volume. A minimum of six rounds of water quality parameter measurements will be made; and well development will continue until the following criteria are met:

- Five borehole volumes (assuming 30 percent porosity in the sand pack) have been removed

- Three consecutive water-quality measurements must satisfy the following criteria:
  - pH = ± 0.3 pH units
  - Temperature = ± 1°C
  - Specific conductivity = ± 10 percent
  - Turbidity <= 5 nephelometric turbidity units (NTUs).

Piezometer development will continue until the purged water is reasonably free of sediments (as determined by the MWH field representative). The total time devoted to developing each piezometer will not exceed 4 hours.

A.2.6.1 Decontamination Procedures

All down-hole equipment associated with well development will be decontaminated prior to use at each borehole location in accordance with SOP 2 provided in Appendix D. After decontamination, down-hole equipment will be kept off the ground and stored on a clean surface (e.g., plastic) until it is used. All decontamination fluids will be disposed of according to the protocols established in SOP 4 provided in Appendix D.

A.2.6.5 Documentation

All measurements made during monitoring well development will be recorded on the Well Development Form (Attachment 1). Required information includes well identification, date and time of development, field personnel, method of development, meter(s) used to measure water quality parameters, calibration procedures, measured water quality parameters, discharge rates, volume of water evacuated from the well, beginning and ending water level, total well depth measurements, and notes on any discussions to terminate development before compliance with the turbidity criteria.

A.2.7 Investigation-Derived Waste Handling

All cuttings will be stockpiled at each drill location on plastic sheeting. The cuttings will be covered at the completion of drilling activities according to SOP 4 provided in Appendix D.

All groundwater and decontamination water generated during well drilling, development, or pump test / sampling activities will be managed according to SOP 4.

A.3 GROUNDWATER EXTRACTION WELLS

A.3.1 Extraction Well Drilling Equipment and Procedures

Casing advance drilling methods (e.g., roto-sonic, ARCH, triple-wall percussion) will be used to install the extraction wells and piezometers. It is anticipated that the total depths of the extraction wells will be approximately 120 feet bgs. The boreholes will have an effective diameter of approximately 12 inches. No circulating fluid, drilling muds, or other additives will be used without pre-approval of the Project Managers. Additives are not expected to be required.

A.3.2 Extraction Well Design and Construction

A.3.2.1 Extraction Well Design

The extraction wells will be constructed of six-inch diameter, flush-threaded, Schedule 80, polyvinyl chloride (PVC) casing connected to flush-threaded sections (30-40 feet total) of stainless steel wire-wrapped screen, with a stainless steel end cap. Each extraction well boring shall also contain a co-installed 1-inch diameter, Schedule 40, PVC piezometer pipe. The extraction well and associated piezometer screened sections will consist of 0.010-inch factory slotted screen. The sand pack around the extraction well and associated piezometer screen will be placed as the well is installed, and will consist of a silica sand pack (i.e., 10/20 mesh sand) that will prevent the migration of fine soil particles into the well. The screen in each extraction well and associated piezometer will be placed according to field observations, and extend approximately 40 feet above the bottom of the well.

A.3.2.2 Extraction Well Construction

Extraction well construction will be initiated within 18 hours of completing the borehole. To ensure the stability of the borehole during well construction, the extraction well will be constructed through the drill string. It is anticipated that each extraction well will be constructed with the bottom of the screen located at approximately 120feet bgs. Refer to Figure 3-2 in Section 3.0 for the extraction well design and completion details.

After the well casing and the capped screens have been positioned, and suspended with centralizers, to the desired depth in the borehole (e.g., extraction well and associated piezometer), a sand-pack consisting of clean, , non-carbonate silica sand will be placed in the annulus between the screen and borehole wall as the drill casing or drive pipe are slowly removed. As the drill casing or drill string are pulled upward, and the sand settles out through the bottom, additional sand will be added so that no less than one-foot of sand always remains inside the bottom end of the drill string during sand pack construction. The depth of the sand pack inside the annular space between the casings and the borehole wall will be continuously monitored using a weighted probe. The sand pack will be added until it is a minimum of five-feet above the screens. The well will be gently surged during emplacement of the filter pack to enhance settlement and to minimize voids. After the intended sand pack height has been reached, the sand will be allowed to settle for at least 20 minutes, after which the depth of the top of the sand pack will be verified. If additional sand is required, it will be added to the borehole. The sand will once again be allowed to settle and the height of the sand pack will be verified.

After the sand pack is in place, a minimum five-foot thick bentonite seal will be placed on top of the sand pack. Bentonite pellets will be poured from the surface to the top of the sand pack as the drill casing or drill strings are slowly withdrawn. The thickness of the bentonite seal will be monitored with a weighted probe. The depth to the top of the seal will then be verified using the weighted probe. When the desired thickness is reached, clean potable water from an approved water source will be added to the borehole, and the bentonite seal will be allowed to hydrate for 30 minutes. For seals competed below the water table, wax coated bentonite tables (e.g., Pel Plug) will be used. The coated tables sink through the water column to the top of the sand pack and are “time released” during hydration. The bentonite seal will be allowed to hydrate for 30 to 45 minutes.

The remaining open annular space of the extraction well will be grouted to eight-feet bgs through a tremmie pipe positioned at the bottom of the annular space. The PVC risers will extend approximately two-feet above the ground surface.

A.3.2.6 Extraction Well Completion

The above ground PVC well casing will be protected from vehicular damage by using Jersey barriers to cordon-off an approximately 5-foot by 5-foot area around each well head until the final completion is installed. For all extraction wells a 14-inch diameter protective steel casing approximately three-feet in length will be installed to a height of approximately 2.5-feet above the ground surface. The protective casing will have a vented lid that can be secured with a lock. A mortar collar will be placed within the protective casing annulus from the ground surface to 6 inches above the ground surface. A 0.25-inch diameter hole (drainage port) will be drilled in the protective casing, approximately 0.5 inch above the mortar collar. The mortar mix will be composed of one part cement to two parts sand. Minimal water will be used to hydrate the mix. Soil will be placed around the casing that slopes away from the steel casing toward the ground surface. Each well completed above ground will be protected by barriers (e.g., Jersey barriers or bollards). Refer to Figure A-1 for construction details for above-ground well / piezometer completions. The construction and completion details for each well and piezometer will be recorded on a Well Completion Form.

A.4 PIEZOMETERS

A.4.1 Piezometer Drilling Equipment and Procedures

Piezometers will be installed using the same manner as the extraction wells above. However, smaller diameter casing advance will be utilized (e.g., six to eight inch casing). It is anticipated that the total depths of the piezometers installed for the Hydrogeological Study will be approximately 120 feet bgs.

A.4.2 Piezometer/Monitoring Well Design and Construction

A.4.2.1 Piezometer Design

The piezometers/monitoring wells will be constructed of 2-inch diameter, flush-threaded, Schedule 40 PVC riser connected to 2-inch diameter, flush threaded sections of Schedule 40 PVC screen, with a PVC end or cap. The screened sections of the piezometers/monitoring wells will consist of 0.010-inch factory slotted screen. The sand pack surrounding the piezometer screen will be placed as it is installed, and will consist of a silica sand pack that will prevent the migration of fine soil particles into the piezometer. The depth interval for the screen in each piezometer will be placed according to field observations. The piezometer screen will consist of 10-foot intervals and will be placed to fully penetrate the saturated thickness of the aquifer. The actual completion details will be decided in the field based on the saturated thickness of the target water-bearing zone and the requirements of aquifer tests performed during the Hydrogeological Study.

A.4.2.2 Piezometer Construction

Piezometer construction will be initiated within 18 hours of completing the borehole. To ensure the stability of the borehole during construction, the piezometer will be constructed through the drill pipe.

After the riser and the capped screen have been positioned to the desired depth in the borehole, a sand-pack consisting of clean, non-carbonate silica sand will be placed in the annulus between the screen and borehole wall as the drill string are slowly removed. As the drill string is pulled upward, and the sand settles out through the bottom, additional sand will be added so that no less than one-foot of sand always remains inside the bottom end of the drill string during sand pack construction. The depth of the sand pack inside the annular space between the casing and the borehole wall will be continuously monitored using a weighted probe. The sand pack will be added until it is a minimum of two-feet and no more than three-feet above the top of the screen. The piezometer will be surged during emplacement of the filter material. After the intended sand pack thickness has been reached, the sand will be allowed to settle for at least 20 minutes, after which the depth of the top of the sand pack will be verified. If additional sand is required, it will be added to the borehole. The sand will once again be allowed to settle and the thickness of the sand pack will be verified.

After the sand pack is in place, a minimum five-foot thick bentonite seal will be placed on top of the sand pack. Bentonite pellets will be poured from the surface to the top of the sand pack as the drill string is slowly withdrawn. The thickness of the bentonite seal will be monitored with a weighted probe. The depth to the top of the seal will then be verified using the weighted probe. When the desired thickness is reached, clean potable water from an approved water source will be added to the borehole, and the bentonite seal will be allowed to hydrate for 30 minutes. For seals competed below the water table, coated bentonite pellets/tablets will be used. The coated pellets/tablets sink through the water column to the top of the sand pack and is “time released” during hydration. The seal will be allowed to hydrate for 30 to 45 minutes.

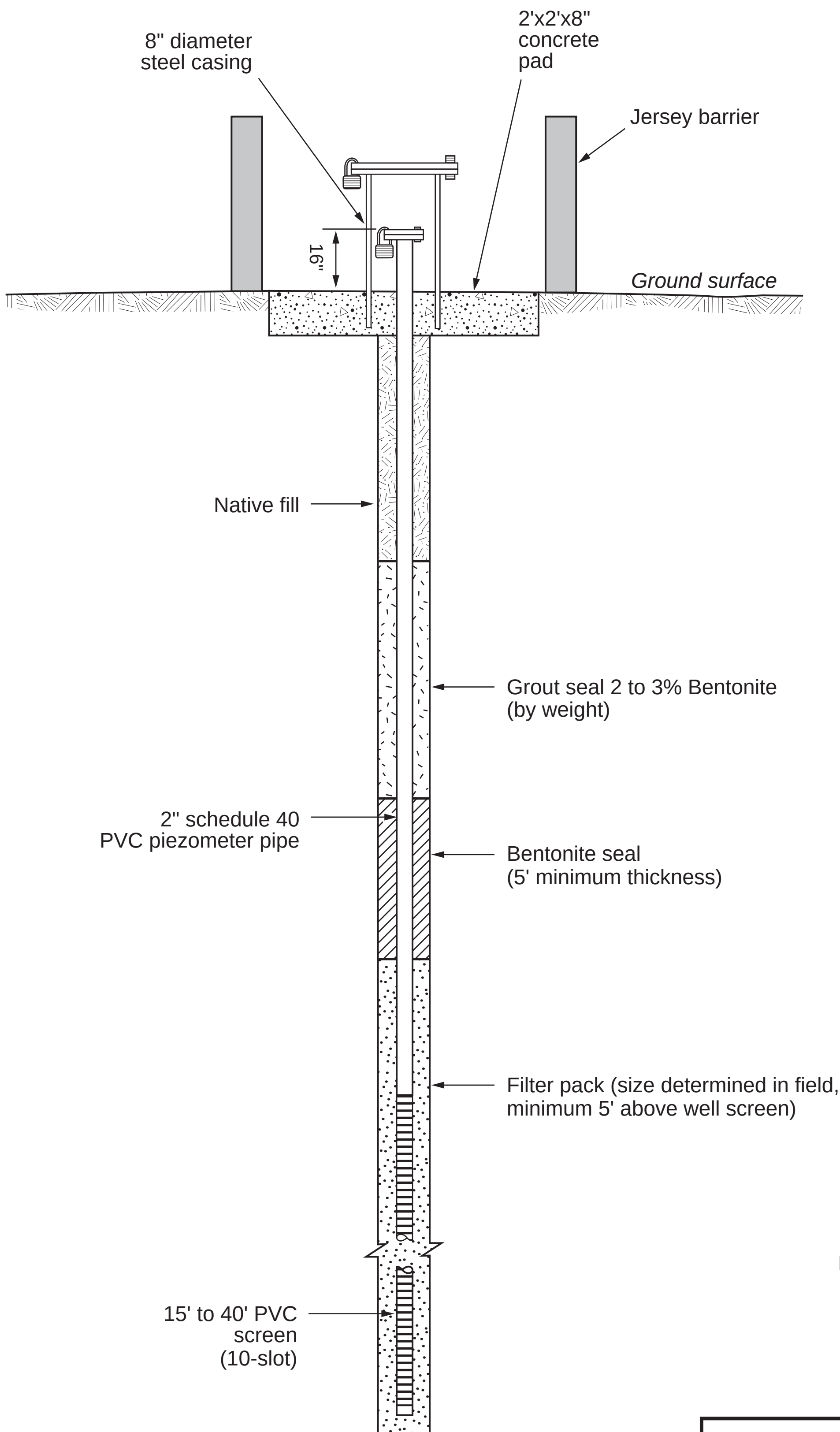
A.4.2.3 Piezometer Completion

The piezometers will be completed above ground with a protective steel casing approximately 5 feet in length that will extend to a height of approximately 2.5 feet above the ground surface. The protective casing will have a vented lid that can be secured with a lock. A mortar collar will be placed within the protective casing annulus from the ground surface to approximately 6 inches above the ground surface. Soil will be placed around the casing that slopes away from the steel casing toward the ground surface. Each well / piezometer completed above ground will be protected by barriers (e.g., Jersey barriers or bollards). A stainless steel identification plate stamped with the well designation will be affixed to each well casing or flush-mount lid (if used). Refer to Figure A-1 for construction details for above-ground well / piezometer completions. The construction and completion details for each well and piezometer will be recorded on a Well Completion Form.

A.5 TOPOGRAPHIC SURVEY / GPS

All extraction wells and piezometers will be surveyed for horizontal control with Global Positioning System (GPS) equipment as specified in SOP 3 contained in Appendix D. The elevation measurements for the monitoring wells and piezometers will be made at a specific mark at the top of the riser casing (measuring point), and at the ground surface.

The horizontal control for each GPS measurement will be within $\pm$ 3.0. The vertical control for each survey measurement will be within $\pm$ 0.01 feet.



Total Depth Approx. 120 feet
(approximate depth to top
of American Falls Lake Bed)

NOT TO SCALE

MWH

FMC

HYDROGEOLOGIC STUDY WORK PLAN

FIGURE A-1

GENERALIZED PIEZOMETER DESIGN AND ABOVE-GROUND COMPLETION

FILE Fig A-1_Generalized Piezometer Design and Above Ground Completion.ai DATE: 24 Oct 2013

ATTACHMENT 1

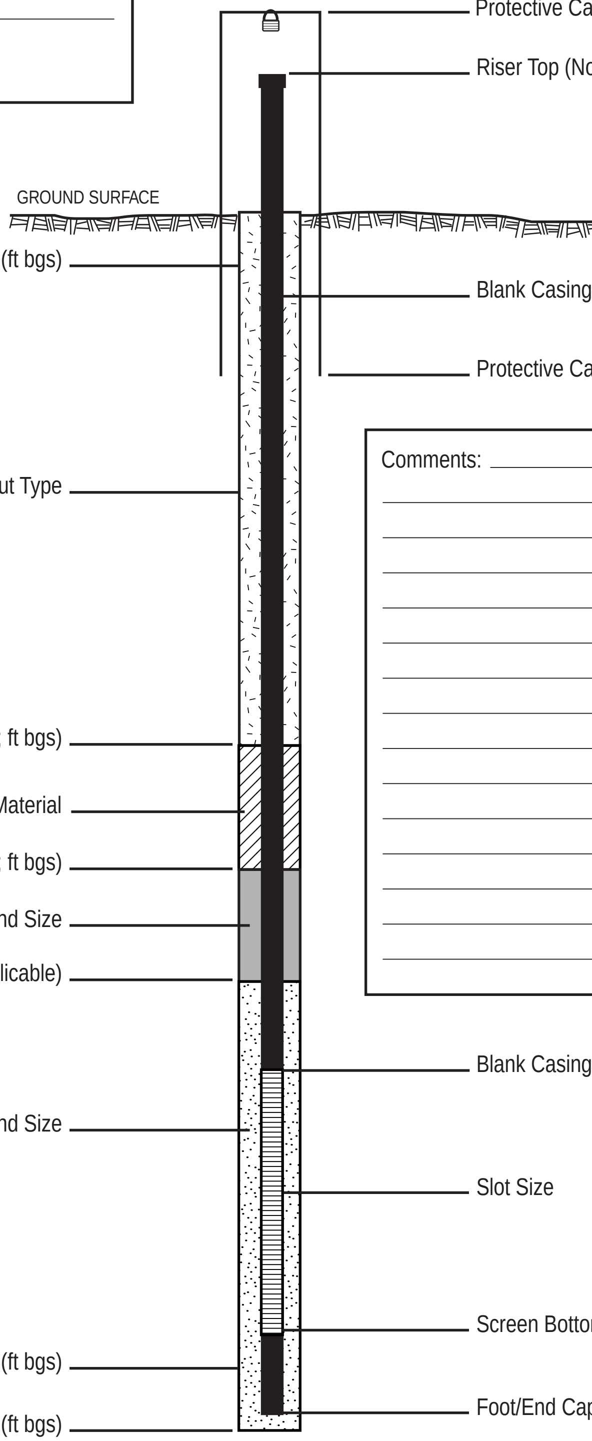
FIELD FORMS

MONITORING WELL COMPLETION FORM

Project No: ______________________

Drilling Company: ______________________

On Base: ☐ Off Base: ☐



Comments: ______________________

NOT TO SCALE

Loc ID/Well ID ______________________	Blank Casing Material/Diameter __________ / __________
Geologist ______________________	Screen Material/Diameter __________ / __________
Date Construction Started ______________________	Protective Casing Type ______________________
Date Construction Completed ______________________	Borehole Diameter ______________________
LOC Type (i.e. Monitoring Well) ______________________	Above Ground Completion ☐ Flush Mount ☐
Riser Material/Diameter __________ / __________	USCS Classification of Screened Interval ______________________

PROJECT NO. ______

MONITORING WELL LOG FORM

BORING LOCATION

Project: _________ Project No: ___________

Date Drilled: ________ Date Completed: ________

Logged By: ________________________________

Water Elevation (ft.): ________________________

Date Measured: ____________________________

Total Depth (ft.): ___________________________

Diameter (in.) ______________________________

Boring ID: ____________________

Northing:_____________ Easting:______________

Ground Surface Elevation (ft.): ________________

Measuring Point (MP) Elevation (ft.): ___________

MP is Top of PVC Casing Datum: NGVD (1929)

Drilling Contractor: _________________________

Drilling Method: ____________________________

Screen: Diameter ______________ Depth ______________ Slot Size ___________________________

Casing: Diameter ______________ Length ______________ Type _____________________________

Sand ______________ Bentonite Seal ___________________ Cement Grout Seal __________________

DEPTH (FEET)	GRAIN SIZE			MAX. PID READING (ppm)	BLOWS (6 IN.)	SAMPLE TYPE*	SAMPLE RECOVERY	USCS/ASTM CLASSIFICATION	GRAPHIC LOG	**LITHOLOGIC DESCRIPTION** (USCS name; color; size and angularity of each component or plasticity; density; moisture content; additional facts)	ELEVATION (FEET)
	% GRAVEL	% SAND	% FINES								

* **C** California Split Spoon Sampler (2.5" I.D.)

S Standard penetration test sampler

c Cuttings

▼ Elevation of ground water

PROJECT NO. ____________

Project: ______________ Project No: ____________________

Boring ID.: _____________

DEPTH (FEET)	GRAIN SIZE % GRAVEL	GRAIN SIZE % SAND	GRAIN SIZE % FINES	MAX. PID READING (ppm)	BLOWS (6 IN.)	SAMPLE TYPE*	SAMPLE RECOVERY	USCS/ASTM CLASSIFICAT.	GRAPHIC LOG	**LITHOLOGIC DESCRIPTION** (USCS name; color; size and angularity of each component or plasticity; density; moisture content; additional facts)	ELEVATION (FEET)

PROJECT NO. ________

PAGE ____ OF _____

MONITORING WELL LOG FORM

MONITORING WELL DEVELOPMENT

DATE: ______________________________ WEATHER: ___________________________________

WELL DESIGNATION: __________________ PROJECT NO: _________________________________

FIELD PERSONNEL:_______________________ SUBCONTRACTOR:_____________________________

WELL SUMMARY:

Depth to NAPL:________________________

Depth of water: _______________________

Total well depth:______________________

Construction: ________________________

____

Start Time_____(a)

End Time______(b)

Total Time_____(b-a)

Location Map

INSTRUMENTATION

pH meter (model): ______________________ Calibrated with buffers: ______4 ______7 ______10

SC meter (model): __________________ Calibrated with standard solution: ___________ μmhos/cm

Turbidity meter (model): __________________ Calibrated with: ______________________________

DEVELOPMENT SUMMARY:

Development method: Bailer____________ Pump (type) _________ Surge Block (type) _________

5 purge volume calculation: ___________________________

Time	pH	SC (μmhos/cm)	Temp (°C)	Turbidity (NTU)	Pumping Rate	Gals. Evacuated	Visual Appearance/Comments

Final

Time	pH	SC (μmhos/cm)	Temp (°C)	Turbidity (NTU)	Pumping Rate	Gals. Evacuated	Visual Appearance/Comments

PROJECT NO. ________

APPENDIX B

PROCEDURE FOR CONDUCTING STEP DRAWDOWN TESTS, CONSTANT DISCHARGE AQUIFER TESTS, AND MULTIPLE WELL CONTAINMENT TESTS

B.1 INTRODUCTION

To prevent further downgradient contaminant migration beyond the FMC OU Site boundary, a hydraulic containment system consisting of multiple extraction wells will be installed along the northeast site boundary. Prior to full-scale implementation, a Hydrogeologic Study will be performed to collect additional hydrogeologic data from the site. As part of the Hydrogeologic Study, aquifer testing will be performed to determine aquifer hydraulic properties (e.g., hydraulic conductivity, transmissivity, storativity, specific yield, delayed yield, sustainable pumping rates, anisotropy, etc.) and to determine the potential for lowering the piezometric surface sufficiently to achieve hydraulic containment. This Plan outlines the methods that will be used to 1) perform 6-hour step-drawdown tests at each extraction well installed to determine specific capacities and sustainable pumping rates, 2) a 24-hour test at the western most extraction wells for determining hydraulic properties using a constant rate aquifer test, and, 3) a 72-hour constant rate pump test at the three initial extraction wells pumping simultaneously to determine whether hydraulic containment is being achieved. This work plan addresses the requirements and logistics associated with these aquifer tests.

B.2 OVERVIEW OF PUMPING TESTS

This section details the following elements of pumping tests:

- Aquifer test principles
- Assumptions and limitations
- Test method selection
- Equipment requirements
- Personnel requirements.

B.2.1 Aquifer Test Principles

Several different types of aquifer tests can be conducted to determine aquifer properties, although the fundamental principles of all tests remain similar. An aquifer test is performed by applying stress to an aquifer by extracting groundwater from a pumping/extraction well and measuring the aquifer response to that stress by monitoring drawdown as a function of time in the pumping well, and/or observation wells or piezometers, at known distances from the well. These measurements are then incorporated into an appropriate well-flow equation to calculate the hydraulic properties of the aquifer.

B.2.2 General Assumptions and Limitations for Pumping Tests

Numerous different types of aquifer tests and well-flow equations exist that may be implemented for a variety of hydrogeologic settings. Each method has a different set of limitations and assumptions. Separate assumptions and limitations exist for confined, semi-confined (leaky), and unconfined (water-table) aquifers. In general, the following assumptions apply to most well-flow equations and hydrogeologic settings:

- The aquifer is of infinite areal extent;
- The aquifer is of uniform thickness;
- The aquifer is approximately horizontal over the area that shall be influenced by the pumping test;
- The aquifer is pumped at a constant discharge rate; and
- The pumping well fully penetrates the entire thickness of the aquifer and thus receives water by horizontal flow.

B.2.3 Aquifer Test Methods

B.2.3.1 Step-Drawdown Tests

A 6-hour step-drawdown test shall be performed at each of the three initial extraction wells to determine specific capacity and optimal pumping rates. The step- drawdown tests will consist of three steps at variable pumping rates.

B.2.3.2 Constant Discharge Aquifer Test

A 24-hour constant discharge aquifer-pumping test shall be used to determine the hydraulic properties of the aquifer at one specific extraction well location(s). This type of test typically involves monitoring the induced groundwater drawdown in several observation wells or piezometers during continuous pumping of the extraction well(s). Longer-term, constant discharge aquifer pumping tests are the most accurate means of evaluating aquifer hydraulic properties of unconfined systems. Additionally, well performance characteristics such as well capacity, well yield, and well efficiency may be determined using a constant discharge aquifer pumping test.

An aquifer recovery test shall be performed to monitor the residual drawdown following the pumping test. An aquifer recovery test provides additional data for calculating aquifer hydraulic properties and allows for an independent check of the pumping test drawdown results. The aquifer recovery test can also be used to evaluate potential borehole storage effects of the pumping well if the pumping test is performed without the use of piezometers or observation wells. Furthermore, recovery data are typically more reliable than drawdown measured during pumping due to the difficulties of maintaining constant discharge from a pumping well.

B.2.3.3 Hydraulic Containment Test

A 72-hour hydraulic containment test shall be conducted while pumping groundwater from the three initial Phase I extraction wells. The purpose of this test is to lower the upgradient water table elevations to a level equal or lower than downgradient elevations in order to achieve hydraulic containment. Each of the extraction wells will be tested simultaneously at pumping rates determined from previous 24-hour constant rate aquifer test.

B.2.4 Equipment Requirements and Definitions

B.2.4.1 Electric Submersible Pump

The submersible pump must be capable of pumping for extended periods of time at a constant discharge rate and must be powered by a reliable source. The discharge pipe or hose shall be equipped with a flow adjustment valve used to regulate flow, which is much more desirable than changing the speed of the pump motor because it allows for better control of the discharge rate.

B2.4.2 Flow Gauge

An in-line flow meter shall be used to measure flow from the extraction pump. The discharge rate will be monitored directly on a meter displaying a constant gallons per minute (gpm) reading and also will be calculated by dividing the quantifiable volume of groundwater collected (at various points during the test) by the time required.

B.2.4.3 Electronic Water-Level Indicator

Manual water-level measurements shall be collected using electronic water-level indicators capable of measuring to 0.01-foot accuracy during all segments of the aquifer test. Electronic water-level indicators will be dedicated to specific wells during the test to avoid errors due to slight differences between indicators. Manual water-level measurements shall be collected as a back-up to water-levels measured using pressure transducers and data loggers. All manual water-level measurements shall be recorded on an aquifer test data sheet, an example of these data collection sheets are included as Figures B-1 and B-2.

B.2.4.4 Pressure Transducer

Pressure transducers shall be used to monitor water levels in pumping wells during aquifer testing. The pressure transducer installed in the pumping well shall be located in the associated piezometer and placed above the level of the pump, but below the anticipated drawdown level. Pressure transducers installed in piezometers shall be placed within the screened interval. The pressure transducers shall be connected to a programmable surface data logger (described below). Transducers are available in different pressure ranges. A pressure transducer shall never be lowered to a depth that produces a greater pressure than the operating range of the transducer. Operating ranges in feet of water for different pressure transducers can be determined by multiplying the pounds per square inch (psi) of the transducer by 2.3. For example, a 10-psi transducer can operate from water table to a maximum depth of 23 feet; a 50-psi transducer can operate down to 115 feet below the water table.

B.2.4.5 Data Logger

A data logger is a small field computer capable of recording a wide range of physical measurements such as pressures, temperatures, specific conductance, and flow. The data logger converts the pressure value sent by the transducer into feet of water above the transducer, and records the values in its memory. The data can then be downloaded from the logger to a PC computer. Each transducer has specific parameters that must be input to the data logger to make the appropriate conversions from pressure units to feet of water.

B.2.4.6 Timing Device

All project team members shall have an accurate timer, wristwatch, or stop watch. All timing devices must be synchronized prior to starting any aquifer pumping test. The importance of accurate time measurements cannot be overstated.

B.2.4.7 Health and Safety Equipment

The FMC Plant OU is covered by the *Site-Wide Health and Safety Plan* ([SWHASP], FMC 2013). The SWHASP provides the Site health and safety organization, specific Site hazards, Site controls, Site evacuation procedures, Site PPE requirements, general health and safety procedures, and emergency procedures. In addition, the SWHASP requires that all Contractors working on the Site will develop their own action-specific Health and Safety Plan (HASP) which will incorporate the general requirements specified in the SWHASP. Each Contractor's action-specific HASPs must provide specific health and safety requirements that are pertinent to the anticipated activities during that action.

B.2.5 Personnel Requirements

Initially, the aquifer pumping tests shall require a minimum of three people at start up. One person shall be responsible for monitoring the flow gauge and adjusting the discharge rate of the pump. One person shall be responsible for starting the data loggers and ensuring that the data loggers continue operating. All team members shall be responsible for taking manual (back-up) water-level measurements with electronic water-level indicators. As the water levels reach a pseudo-steady state, fewer team members shall be required.

B.2.6 Responsibilities

B.2.6.1 RD Project Manager

The Project Manager shall select the aquifer testing methods with assistance from the project team. The Project Manager is responsible for the preparation of groundwater pumping subcontracts and for regulatory interaction, appropriate permitting, and potential treatment of contaminated groundwater generated during aquifer testing in areas with contaminated groundwater. Additionally, the Project Manager coordinates the project team and ensures access to necessary staffing and equipment resources. For the purpose of these aquifer tests, Rob Hartman (MWH) is the Project Manager.

B.2.6.2 Project Hydrogeologist

The Project Hydrogeologist is responsible for the successful completion of the testing program in a technically sound manner. The Project Hydrogeologist is responsible for the design of the testing methods, data acquisition methods, and data analysis. The Project Hydrogeologist must have thorough understanding of the site hydrogeology to the extent known and must be have knowledge and extensive experience using field instruments and equipment, such as pressure transducers, data loggers, pumps, flow gauges, and meters. The Project Hydrologeologist must possess knowledge in the areas of well hydraulics and aquifer mechanics and is responsible for data reduction and analysis. The MWH Project Hydrogeologist for these aquifer tests shall be Jesse Stewart.

B.2.6.3 Field Team Leader

The Field Team Leader coordinates logistical aspects of the testing program and is responsible for accurate and precise data collection by all field team members. The Field Team Leader assists in the design of the aquifer testing program and must have working knowledge of equipment and instruments used in testing methods implemented. William Bragdon shall serve as the MWH Field Team Leader.

B.2.6.4 Project Staff

Project Staff assist in data acquisition and data reduction and in the design of the aquifer testing method and with data analysis. Project staff shall be chosen from a pool of qualified hydrogeologists and field technicians, based on program schedule. At least one member of the Project Staff will be on-site at all times during aquifer testing.

B.3 TEST DESIGN CONSIDERATIONS

The following design components must be evaluated prior to initiation of a pumping test:

- **Extraction wells.** Each of the extraction wells will be designed as part of the Hydrogeologic Study for pumping and must be fully developed and capable of sustained and prolonged pumping. The first three Phase I extraction wells will be located in northeast portion of the Former Operations Area as per Figure 1-3). Nearby observation wells or piezometers are required for distance-drawdown calculations (see Figure 1-3).

- **Choice of piezometers.** Ideally, water levels shall be monitored in as many nearby monitoring wells or piezometers as feasible. Prior to conducting the pumping test, zones of influence may be estimated using well-flow equations to determine which wells likely will show a drawdown response. It is beneficial to use monitoring wells and piezometers located upgradient, downgradient, and cross-gradient from the pumping well to evaluate hydraulic anisotropy and or heterogeneities.

- **Step Tests.** A 6-hour variable rate step-drawdown test shall be performed in each of the three extraction wells to calculate specific capacity and determine the pumping rate for the constant rate test. Step tests will also be performed in any additional extraction wells installed (up to two additional wells) to determine well specific capacity and substantial pumping rates.

- **Constant Discharge Aquifer Test.** A 24-hour constant discharge aquifer test will be performed in the western-most extraction well. This test will be used to determine the hydraulic properties of the aquifer at a single pumping/extraction well location. This type of test typically involves monitoring drawdown in several observation wells and/or piezometers. Long-term, constant discharge aquifer pumping tests are the most accurate means of evaluating aquifer hydraulic properties of unconfined systems. In addition, well performance characteristics such as well capacity, well yield, and well efficiency may be determined using a constant discharge aquifer pumping test.

- **Hydraulic Containment Test.** Once the first three extraction wells are in place and the variable rate step-drawdown and constant rate tests are completed, a hydraulic containment test shall be performed. Each of the extraction wells will be tested simultaneously at pumping rates determined from previous aquifer tests. Pumping rates may need to be varied or tuned during the test due to well interference effects between extraction wells. Water level measurements will be measured in extraction wells, monitoring wells and piezometers. The objective of this test is to lower the upgradient water table elevations to a level equal or lower than downgradient elevations in order to achieve hydraulic containment.

- **Duration of Pumping Test - Unconfined Aquifer.** The cone of depression that results from pumping expands much more slowly for unconfined aquifers than for confined aquifers. The generally accepted minimum duration pumping test for an unconfined aquifer is 72 hours. However, the initial constant rate pump test will be performed for 24 hours to primarily establish well yields to be expected during the final 72-hour hydraulic containment pump test.

- **Size of pump.** The size of the pump shall be based on the drawdown requirements and estimated specific capacity of the well. Pumping rates will be determined from evaluation step drawdown tests that will be performed prior to the constant discharge aquifer pumping tests to determine the flow rates from the constant rate tests and the specific capacity.

- **Discharge Rate.** The discharge rate shall be based on the results of a step-drawdown and initial 24-hour constant rate testing program. The specific capacity calculated from the step-drawdown and constant rate tests shall be used to estimate the desired drawdown and pumping rate. Because of the uncertainty in the step test calculations, a level of safety shall be factored into the desired drawdown level to ensure that the water level is not drawn down to the pump. If the water level is lowered to the pump, pumping shall be terminated immediately and collection of recovery data shall be started until the aquifer recovers to static conditions.

- **Pre-Test Water Level Measurements.** One barometric pressure transducer shall be installed in the pumping well, and transducers shall be set into observation wells at least two days prior to the start of pumping to monitor pre-test trends and to correlate changes in water levels to changes in barometric pressure. Measurements shall be recorded every hour with a linear scale set on the data logger.

- **Pumping Test Water Level Measurements.** Water-level measurements during the test shall be collected at various frequencies. Individual water-level indicators can be dedicated to monitoring wells and piezometers. Pressure transducers with data loggers shall be installed in extraction well piezometers and up to ten additional piezometers (i.e., PZ01- PZ-06) and monitoring wells (see Table 3-1) within the anticipated zone of influence. Manual water-level measurements during the constant discharge aquifer pumping test shall be collected at various frequencies depending on the proximity of the monitoring wells and piezometers to the pumping well. Table B-1 lists a suggested measurement frequency schedule that can be followed during constant discharge aquifer pumping tests. The measurement frequency schedule presented in Table B-1 is a suggested frequency and may need to be modified to meet specific needs for individual monitoring wells and piezometers. Water-levels measured electronically using pressure transducers and data loggers shall be collected using the logarithmic time interval cycle shown in Table B-2. The logarithmic time interval allows for extremely rapid measurements during the initial portion of the test and then gradually slows the measurement frequency during later segments of the test. Table 3-1 provides a list of all piezometers and wells to be measured during the various pump tests.

- **Aquifer Recovery Test Water Level Measurements.** Water levels shall be measured during the recovery portion of the constant-rate test according to the same schedule as the pumping portion of the test (see Tables B-1 and B-2). That is, water levels shall be collected more frequently immediately after the pump is shut off and less frequently in the later stages of the recovery. The data loggers shall be reset to collect water-level recovery data, using a logarithmic interval. The recovery portion of the constant-rate test often provides some of the best data because, when the pump is shut off, water levels recover without the influence of well loss, erratic pumping, or turbulent flow near the pumping well provided that the check valve in the well functions properly.

- **Collection of Water Samples**. Groundwater samples will be collected as described in Section 3.0 of the Plan and documented on the water sampling form provided in Appendix C.

TABLE B-1

**SUGGESTED MANUAL MEASUREMENT FREQUENCY
USING CALIBRATED ELECTRONIC WATER-LEVEL INDICATORS
FMC OU, POCATELLO, IDAHO**

ELAPSED TIME	MEASUREMENT FREQUENCY
0-20 minutes	30 seconds
20-40minutes	2 minute
40-60 minutes	5 minutes
60-120 minutes	10 minutes
2-12 hours	1 hour
12 hours to 3 days	2 hours

TABLE B-2

**TIME INTERVAL SCHEDULE
FOR PRESSURE TRANSDUCERS AND DATA LOGGERS
FMC OU, POCATELLO, IDAHO**

LINEAR CYCLE	MEASUREMENT INTERVAL	TOTAL DATA POINTS PER CYCLE
30 minutes	1 second	1800
30 minutes – 6 hours	10 second	1980
6 hours -72 hours	10 minute	396

- **Discharge Water.** The discharge water from the pumping tests will be collected in portable water containers for appropriate management per SOP 4 (Appendix D).

- **Miscellaneous.** Precipitation events must be recorded in the field notes, including time of onset, and duration. Barometric readings shall be measured by a barometric transducer and data logger. The barometric transducer shall be suspended in the pumping well to minimize diurnal variations due to temperature changes. Barometric pressure effects on water levels shall be evaluated during the constant-rate test and factored into the analysis if necessary. For shallow zone wells, the passing of heavy equipment or trains shall be noted on the field logs.

B.4 AQUIFER TESTING PROCEDURES

B.4.0.1. As described in Section B.1, several piezometers will be monitored during the step-drawdown tests, the 24-hour constant rate-pumping test, and the 72-hour hydraulic containment test to determine aquifer characteristics. For each test, Table B-3 outlines the specific design parameters for each test for the pumping wells, piezometers, control point wells, water level measurements and frequency, and collection of water samples. Table B-3 also provides recommendations for the pump size, discharge rate, discharge water/investigation-derived waste (IDW), traffic control, and other miscellaneous items that may influence or need to be considered during the test.

TABLE B-3

SITE-SPECIFIC CHARACTERISTICS AND DESIGN CONSIDERATIONS
FMC OU, POCATELLO, IDAHO

Design Parameter	Step-Drawdown and Constant Rate Extraction Well Test	72-Hour Hydraulic Containment Test
Extraction Wells	Each extraction well will be constructed with 6" diameter casing. The sand filter pack size, screened casing slot size and screened interval for each extraction well will be selected based on the static groundwater level in the borehole, stratigraphic interpretations and groundwater chemistry profiling during drilling activities and after consulting with the MWH Hydrogeological Manager.	Each extraction well will be operated simultaneously at the optimal flow rate determined during step-drawdown tests and the constant rate test.
Observation Points Distant Wells	Each extraction well will be paired with piezometers as detailed in the Plan. The extraction wells and specific piezometers will be monitored using pressure transducers. The monitoring wells listed in Table 3-1 will be used as distant wells during the test, and specific up- and downgradient monitoring wells installed for the system. Data from these wells will be used to determine the extent of drawdown only.	At a minimum, piezometers both up- and downgradient of each extraction well will be monitored to determine water table elevation. Piezometers shall be measured manually using electronic water level indicators. However, the same water level indicator shall be used in piezometer pairs so measurement can be correlated. Additionally, each water level indicator used for the test shall be calibrated against a "master tape." This is completed by measuring three different depths to water in different wells with each tape followed by creating a linear regression for each indicator for determining a correction to apply. The monitoring wells listed in Table 3-1 will be used as distant wells during the test and specific up- and downgradient monitoring wells installed for the system. Water levels in these wells will be recorded manually only. Data from these wells will be used to determine the extent of drawdown only.
Control Point Wells	Well 165 will be designated as the control point well. No drawdown is anticipated at this location during individual well tests. Manual water levels will be collected daily at this well.	Well 165 will be designated as the control point well. No drawdown is anticipated at this location during individual well tests. Manual water levels will be collected daily at this well.
Size Of Pump	A submersible pump shall be used during the test. The pump size will be based on development. A pump controller shall be used to vary the speed and pumping rate of the pump. A throttling valve on the discharge line of the pump shall be used to provide additional flow control.	Dedicated pumps will be used for the test. Pump size for individual wells will be based on results of step-drawdown tests and the constant rate test.
Duration Of Test	Since this test assumes an unconfined aquifer, the constant rate test will last for a total of 24 hours, plus a step drawdown test that shall consist of three steps lasting for approximately 2 hours each. The steps shall be performed at approximately 75, 95, and 115 gpm, but may be greater or lower depending on the well capability (development of the well will assist in determining pumping capability). After the step test has been completed, the system shall be allowed to equilibrate at least overnight, prior to commencing the constant rate aquifer-pumping test.	Since this test assumes an unconfined aquifer, the test shall last for a minimum of 72 hours. Total test duration may be much longer in order to achieve hydraulic containment.
Discharge Rate	This shall be based on the results of the step-drawdown test that will be conducted prior to beginning the aquifer-pumping test. Currently, it is estimated that approximately 90 to 120 gpm of water shall be produced from each extraction well for the duration of the test based on preliminary modeling.	Discharge rates shall be based on the results of the individual extraction well constant rate aquifer tests

TABLE B-3

SITE-SPECIFIC CHARACTERISTICS AND DESIGN CONSIDERATIONS
FMC OU, POCATELLO, IDAHO
(continued)

Design Parameter	Step-Drawdown and Constant Rate Extraction Well Test	72-Hour Hydraulic Containment Test
Pumping Test Water Level Measurements And Frequency	Measurements shall be made using the temporary pressure transducers and dataloggers at frequencies outlined in Table B-2. Backup measurements shall be made using an electronic water-level indicator at frequencies outlined in Table B-1.	Measurements will be made at each of piezometers prior to the test, 10 minutes after start-up, and then hourly for the next 8 hours using an electronic water-level indicator. After 8 hours, water level will be collected on a frequency of every four hours until the end of the test. One measurement will be completed prior to shut down. Measurements will also be made using dedicated pressure transducers in the extraction wells and piezometers, if available.
Aquifer Recovery Test Water Level Measurements	Measurements shall be made using the temporary pressure transducers and dataloggers at frequencies outlined in Table B-2. Backup measurements will also be made using an electronic water-level indicator at frequencies outlined in Table B-1.	A recovery test will not be performed for the hydraulic containment test.
Collection Of Water Samples	Water samples shall be collected from the extraction wells as described in Section 3.5.2 of the Plan. Samples will be sent to the laboratory and analyzed for as provided in Table 3-2. Field parameters will also be monitored when analytical samples are collected.	Water samples shall be collected from the extraction wells as described in Section 3.0 of the Plan and documented on the water sampling form provided in Appendix C. Samples will be sent to the laboratory and analyzed as provided in Table 3-2. Field parameters will also be monitored when analytical samples are collected.
Discharge Water	Discharge water will be managed per SOP 4 (Appendix D).	Discharge water will be managed per SOP 4 (Appendix D).
Traffic Control	None anticipated for this test	None anticipated for this test
Miscellaneous	All meteorological parameters and physical disturbances that could impact the results of the test shall be noted in the field logbook. A pressure transducer for reading barometric fluctuations will be installed in the extraction well during the test.	All meteorological parameters and physical disturbances that could impact the results of the test shall be noted in the field logbook. A pressure transducer for reading barometric fluctuations will be installed in the production well during the test.
	A diesel-fueled portable generator will be used to supply power to all field equipment.	A permanent power supply shall be in place. However if permanent power supply is not available, a portable diesel-fueled generator will be used.

B.4.1 STEP-DRAWDOWN TEST PROCEDURES

B.4.1.1. Continuous data logging equipment shall be used wherever possible, although manual backup measurements shall also be collected as discussed above. All of the data loggers shall be synchronized to the correct day, date, and time. All project team members must synchronize their watches to the correct time datum.

1. Remove the well head expansion cap from all observation wells and piezometers, as well as the extraction well/associated piezometer. Allow all wells to equilibrate to atmospheric conditions.

2. Record the static water level in all test wells using electronic water-level indicators.

3. The pump shall be set in the well at the desired pumping level, usually within the screened interval. The extracted groundwater from the aquifer testing will be managed and characterized as described in SOP 4 (Investigation Derived Waste) contained in Appendix D. If determined to be non-hazardous, the water will be utilized for dust-suppression activities on site.

4. Determine the appropriate depth of the transducer for the pumping well. The transducer shall be placed at least 3 to 5 feet above the pump if possible to minimize interference with the pump. In some instances, installation of the transducer below the pump may be required. Lower the transducer to the target depth in the pumping well piezometer. Allow the well to equilibrate to static water levels.

5. Install pressure transducers in all of the selected observation wells/piezometers included in the test well in a manner similar to that described above. In typical applications, a 10-psi transducer (highly accurate up to 23 feet below the water table) is adequate for monitoring drawdown in observation wells. Secure transducer cables above ground surface and affix duct tape to each cable to monitor if any slippage occurs.

6. Connect the pressure transducers to the data logger. Enter the required transducers parameters and other test parameters in the data logger and record transducer input parameters on the transducer form shown in Figures B1 and B2. The data logger typically prompts the user to record water levels below the top of casing (TOC) or surface. Surface refers to a static water level datum. The instrument is therefore "referenced" or "zeroed" to either a static water level or to a value input by the operator. Water levels below static water level shall be recorded as negative values. For pumping test purposes, water levels can be recorded relative to either "TOC" or "surface". Note that referencing to "surface mode" minimizes mistakes in the field. An accurate record of all input parameters and field observations must be included in a field log.

7. "Zero" the pressure transducer/data logger to static water levels (or, alternatively, enter the TOC value for each well). Confirm static levels (or TOC-adjusted values) with an electronic water-level indicator.

8. For the pumping well and for observation wells close by the pumping well, the early time data will be recorded at very frequent intervals. This is best accomplished using the logarithmic data-recording mode shown in Table B-2, where each transducer is pre-set to start recording prior to but as close as possible to when the pump is started. Set the loggers to the "delayed start mode" to begin at a pre-determined time. Ideally the loggers will begin recording one second before pumping begins. Other project team members must be prepared to begin manually measuring and recording water levels on a pre-determined frequency (see Table B-1).

9. *TEST START-UP* — This is the critical step. Once the pump is started, there is no going back. At a pre-determined time that is close to but AFTER the pre-determined time set for the loggers to begin recording data, one person must simultaneously start the pump and quickly stabilize the discharge rate to the discharge rate of the first "step". The data recorded by the transducers and data loggers can be viewed following completion of the logarithmic data recording cycle (after 10 minutes). Water-levels measured by the transducers shall be similar to the manually measured water levels. After running the test for exactly 2 hours, the discharge rate is quickly "stepped up" to a higher pumping rate, and the frequency of water level measurements are collected at a frequency comparable to that required at the start of a new test. After running the test for exactly 2 hours, the discharge rate is again quickly "stepped up" and the process is repeated.

B.4.2 CONSTANT RATE PUMPING TEST PROCEDURES

B.4.2.1. After completing the step-drawdown tests, the site shall be allowed to recover at least overnight so that equilibrium conditions can be re-attained. During this time, the data from the step test shall be evaluated and the ideal pumping rate for the test will calculated. The following procedure shall then be used to conduct the aquifer pump test:

1. Procedures 1-8 of the step test shall be followed prior to commencing the aquifer pumping test.

2. *TEST START-UP* — This is the critical step. Once the pump is started, there is no going back. At a pre-determined time that is close to but AFTER the pre-determined time set for the loggers to begin recording data, one person must simultaneously start the pump and quickly stabilize the discharge rate to the desired discharge rate (determined from a step test, slug tests, or previous aquifer tests). The data recorded by the transducers and data logger can be viewed following completion of the logarithmic data recording cycle (after 10 minutes). Water-levels measured by the transducers shall be similar to the

manually measured water levels. It is always beneficial to plot the time and drawdown data in the field to ensure that the pumping rate and the drawdowns are adequate.

B.4.3 Aquifer Recovery Tests

B.4.3.1. An aquifer recovery test shall always be completed following a constant rate pumping test. As stated above, recovery data are often more reliable than drawdown data due to difficulties of maintaining an absolute constant discharge rate from a pump.

1. Complete a constant discharge aquifer pumping test in the manner detailed above.

2. Wait for data logger to record a point (every 200 minutes at this time), then complete a round of water levels.

3. At a pre-determined time (a minimum of 72 hours after pumping begins), simultaneously turn off the pump, and restart the data loggers to measure aquifer recovery using the logarithmic data recording mode (Table B-2). Stop the pump immediately (one second) after restarting the data logger. Manual measurements shall be collected using electronic water-level indicator using the suggested frequency presented in Table B-1. Continue recording the recovery data until the water levels return to static (or at least 90 percent of original static levels). At this time the test is completed.

4. Carefully download the field data from the transducers to a computer. Obtain a hard copy and a master electronic copy to be stored inviolate.

B.4.4 HYDRAULIC CONTAINMENT TEST PROCEDURES

B.4.4.1. Once the constant rate aquifer test has been completed and the wells have returned to static conditions, a hydraulic containment test will be performed. For this test, each of the extraction wells shall be started simultaneously at the optimal pumping rate determined during the constant rate aquifer test. The objective of this test is to determine whether hydraulic containment is being achieved. Therefore, water levels will be collected from the entire extraction well system and associated observation wells, but are not time critical like a constant rate aquifer test. Hydraulic containment will be achieved when upgradient water table elevation is equal or less than downgradient water table elevation. Additionally, pumping rates in wells may need to be adjusted due to super position of drawdown between extraction wells. Water levels in extraction wells will need to be monitored closely so that maximum drawdown will not exceed pump levels. The hydraulic containment test shall be operated for a minimum of 72 hours to determine long-term effects of the extraction system. Specific measurement times are presented in Table B-1 and B-2.

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Figure B-1

AQUIFER TEST DATA SHEET
(PUMPING WELL)

Page ___ of ___

PROJECT NAME: ________________ PROJECT NO: ________________ WELL NO: ________________

DATE: ________________ PUMP DEPTH: ________________ TEST NO: ________________

TYPE OF TEST: ________________ PUMPED WELL NO: ________________ DISTANCE FROM PUMPING WELL: ________________

MEASURING EQUIPMENT: ________________ HYDROGEOLOGIST: ________________

Time Data Pump On: Date/Time__________(t) Pump Off: Date/Time__________(t') Duration of Aquifer Test: Pumping:__________ Recovery:__________			**Water Level Data** Pretest Water Level__________________ Static Water Level:__________________ Measuring Point:__________________ Elevation of Measuring Point:__________			**Water Quality**			
Date	Time Since Pump Started t (min)	Time Since Pump Stopped t' (min)	Depth to Water (ft)	Pressure Transducer (XD)	Flow Rate (gpm)	pH	Specific Conductivity	Temperature	Comments on factors affecting test data

Conversion Factors: 1 PSI = 2.31 feet **1 cubic foot = 7.48 gallons**

Figure B-2

AQUIFER TEST DATA SHEET
(OBSERVATION WELLS)

Page ___ of ___

PROJECT NAME: ____________ PROJECT NO: ____________ PIEZO NO: ____________
DATE: ____________ PUMP DEPTH: ____________ TEST NO: ____________
TYPE OF TEST: ____________ PUMPED WELL NO: ____________ DISTANCE FROM PUMPING WELL: ____________
MEASURING EQUIPMENT: ____________ HYDROGEOLOGIST: ____________

Time Data Pump On: Date/Time_________ Pump Off: Date/Time_________ Duration of Aquifer Test: Pumping:_________ Recovery:________		**Water Level Data** Pretest Water Level________________ Static Water Level:________________ Measuring Point:__________________ Elevation of Measuring Point:__________			**Time Data Continuation**		**Water Level Data Continuation**		
Date	Time	Depth to Water (ft)	Pressure Transducer (XD)	Flow Rate (gpm)	Date	Time	Depth to Water (ft)	Pressure Transducer (XD)	Flow Rate (gpm)

Conversion Factors: 1 PSI = 2.31 feet 1 cubic foot = 7.48 gallons

APPENDIX C

Groundwater Sampling Field Form

GROUND-WATER/SURFACE WATER SAMPLING LOG

Project No: ______________________ Sample Location __________________ Surface Water ☐ Ground Water ☐

Sampling Personnel_____________ Date___________ Start Time ___________ Weather____________________

Depth to Water___________ Depth to Product _______ Product Thickness _______ Measuring Point _______________

Borehole Dia. _____________ Calculated Purge Volume ________ Gallons Total Casing Depth/Dia. _________

Sampling Method: Dedicated Submersible Pump ☐ Portable Submersible Pump ☐

Dedicated Bladder Pump ☐ Portable Bladder Pump ☐ Surge/Bail ☐ Surge Block Type ______

Disposable Bailer ☐ Bailer Type _______________

Pump Started ________ Pump Stopped ________ Total Gallons _______ Organic Vapor at Well Head ________

Time (military)	pH	SC (umhos/cm)	Temp (°C)	Eh-ORP (millvolts)	D.O. (mg/L)	Turbidity (NTU)	Vol Evac. (gal.)	Comments/ Flow rate

Final:

Time	pH	SC	Temp	Eh-ORP	D.O.	Turbidity	Ferrous Iron	Vol Evac.	Comments/Flow rate

COMMENTS: ____

HYDROLAB: pH Calibration Buffers: 4 ☐ 7 ☐ 10 ☐ Eh Reference Solution _____________

SC Reference Solution _____ umhos/cm Turbidity Reference Solution _________ NTUs

Sample Name ________________________ TIME ____________ VOCs ☐ Sulfide ☐ Anions/Alkalinity/TDS ☐

TOC ☐ Cations ☐ Trace Metals ☐ SVOCs ☐ Perchlorate ☐ Explosive ☐ TPH Gas ☐ Dioxin/Furans ☐

TPH Diesel/Motor Oil ☐ ______________ ☐ ______________ ☐ ______________ ☐ ______________ ☐

MS/MSD _____________ BD _______________ BD Name/TIme _________________________ TB _____________

APPENDIX D

Standard Operating Procedures

STANDARD OPERATING PROCEDURE 1

SITE ACCESS AND CLEARANCE REQUIREMENTS

This SOP has been revised from SOP No. 1 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

STANDARD OPERATING PROCEDURE 1

SITE ACCESS AND CLEARANCE REQUIREMENTS

TABLE OF CONTENTS

1.0 INTRODUCTION

This standard operating procedure (SOP) defines minimum requirements that shall be fulfilled by all personnel in order to obtain site access and clearance(s) necessary to perform assigned tasks at FMC. It is the Contractor's responsibility to determine necessary clearances. Access and clearances required may include, but are not limited to, the following:

- Site access and clearance: FMC Project Manager
- Digging, Drilling, Excavation: FMC and/or FMC's contractor for FMC-owned property and Idaho Dig Line for off property locations (not anticipated).
- Public Road Closure: Idaho Department of Transportation
- Union Pacific Railroad where digging, drilling, or excavations are near the active Union Pacific Railroad tracks.

Close attention shall be paid to minimum waiting periods required before certain authorizations and clearances can be issued. Proper documentation shall be maintained at all times as evidence that authorization/clearance has been obtained. The minimum requirements for the above list are specified in this SOP. In addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) and develop their own action-specific Health and Safety Plan (HASP). The Contractor's action-specific HASP must incorporate the general requirements specified in the SWHASP and provide specific health and safety requirements that are pertinent to the anticipated activities during Contractor actions.

2.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved as needed. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Responsible for ensuring all personnel, including sub-contractors, have the applicable authorization(s) and clearance necessary to perform tasks as assigned. The RDRA Project Manager shall coordinate with other key project staff and FMC personnel to accomplish this task.

Field Team Leader (FTL): Responsible for ensuring access requirements are observed by field personnel at all times, preparing daily logs of field activities, and ensuring that documentation of all appropriate authorization(s) and clearance are at the work site at all times.

Field Technician (or other designated personnel): Assists the FTL with the implementation of field tasks.

3.0 ACCESS TO FMC-OWNED PROPERTY

The entrances to the FMC-owned property will normally be locked at all times. Entry onto the Site will be performed in accordance with the FMC Site-Wide Health and Safety Plan Section 5.1. RDRA contractors and subcontractors will have access to the gate key or code based upon approval and coordination with the RDRA Field Team Leader (FTL) and/or the RDRA Project Manager. All other contractors and/or visitors must obtain approval from FMC and schedule arrival and departure dates/time with FMC at the FMC Pocatello office.

All RDRA contractor and subcontractor employees performing work at the FMC Plant OU will be required to check in and check out with the FTL through the use of a sign-in sheet. A daily field log and sign in sheet will be kept at the work site by the FTL that will document all on site personnel and visitors. Persons not meeting the minimum standards as defined in SWHASP will not be allowed access by the FTL.

4.0 HOT WORK CLEARANCE

All cutting, welding, brazing, and other hot work will comply with all safety requirements of FMC SWHASP and the Safety, Fire Prevention and Health (AFOSH) Standard 91-5, OSHA 1910.252, and the National Fire Protection Agency (NFPA) codes.

Under this standard, personnel or contractors involved in RDRA activities that require welding, cutting, brazing, or other “hot work” shall fulfill the following requirements:

1. The RDRA contractor shall contact the FMC and the FTL prior to performing any hot work. This will allow the appropriate review and inspection of the work area prior to cutting, welding, brazing, or other “hot work”. As the FMC Plant OU is expected to be fully decommissioned at the time of the RDRA field work, each case will be reviewed for potential hazards or other safety concerns. After such review, written approval (e.g., documented in the site log book) must be obtained from the FTL prior to any RDRA contractor performing hot work on the site.
2. Provide adequate number of portable fire extinguishers and place them as close to the work area as possible.

5.0 UTILITY CLEARANCE ON FMC-OWNED PROPERTY

Underground and aboveground utility clearance will be completed before subsurface investigations commence on FMC-owned property (including obtaining an excavation permit consistent with the requirements of Section 3.2.8 of the SWHASP) or off property (see Section 6 and 7 for requirements pertaining to investigations on lands not owned by FMC). The area within a 5-foot radius of each subsurface sampling location will be cleared using the following protocol:

1. Review available facility utility maps provided by FMC and/or FMC's contractor, A&E Engineering.
2. Mark the proposed sampling locations and the utility lines in the immediate vicinity using a marker, stake, flags, or paint.
3. Verify proposed sampling locations with FMC plant or A&E employees with knowledge of the utilities to discuss undocumented utilities, potential obstructions, etc.
4. Scan the surface with a magnetic locator according to the manufacturer's directions to search for the presence of buried utilities and other obstructions.
5. Hand auger or push a probe to a depth of 4 to 5 feet below ground surface in areas where historic maps or historic knowledge of subsurface utilities are not available.
6. Overhead telephone and power lines shall also be taken into account when selecting drilling/excavation locations.
7. The RDRA contractor shall notify FMC and A&E in case of any suspicion or confirmation of damage to any underground utilities.

6.0 UTILITY CLEARANCE ON LANDS NOT OWNED BY FMC

Although subsurface investigation is not expected off FMC-owned property as part of the scope of this RDRA, the Idaho Dig Line provides one central location for contractors and the general public to call and notify multiple utility companies of intended excavation (off FMC-owned property). Information, contractor responsibilities, and an online tool to notify Idaho Dig Line of planned work can be found by calling 800-342-1585. Idaho Dig Line shall be notified at least 48 hours, but no more than seven (7) days, prior to drilling or excavation. Notices of drilling or excavation are good for 14 calendar days. Requests for a utility meeting with locators are scheduled through the Idaho Dig Line. If drilling or excavation on a single project lasts more than 14 days, Idaho Dig Line shall be notified prior to the deadline to update clearance permits. To obtain clearance for any drilling or excavation off FMC-owned property, MWH and/or its RDRA subcontractor shall provide Idaho Dig Line with the following information:

- Company information including company name, address, and telephone number
- The name and telephone number of the caller
- Type of work to be accomplished including information regarding anticipated depth and information regarding horizontal or vertical boring
- Date of proposed work
- Precise location of the proposed drilling/excavation site. This shall be a detailed description including street address, street names and numbers, subdivision lot number if available, direction and distance relative to street or intersection (north, south, east, or west), and any other relevant information. If possible, the site shall be pre-marked with white paint, stakes, or flags
- Provide a location map if requested by Idaho Dig Line
- Marking instructions (e.g., portion of site to be cleared by Idaho Dig Line)
- Field personnel contact name and telephone number

If subsurface investigation is required off FMC-owned property, the RDRA contractor/excavator shall work with MWH to provide this information. MWH shall obtain a Location Request Number from the Idaho Dig Line representative. This is a number that references the caller with the details of the proposed excavation and is helpful when contacting a member utility or Idaho Dig Line for further assistance. MWH and the RDRA subcontractor shall possess this number at all times on job sites to prove compliance with state statutes.

After Idaho Dig Line and local utilities have marked the proposed drilling or excavation site, a minimum clearance of five feet will be maintained between a marked and unexposed underground facility and the cutting edge or point of any power-operated excavating or earth moving equipment. If excavation is required within five feet of any marking, the excavation shall be performed utilizing a hand auger or probe point to check for underground utilities. MWH or the subcontractor shall notify FMC and the Idaho Dig Line in case of any suspicion or confirmation of damage to the underground utilities.

Underground utilities are marked with paint or pin flags with a color scheme representing different utilities. The way that these lines will be identified by the various utilities are defined by the following legend:

Red = Electric

Yellow = Oil and Gas

Orange = Communications including Cable TV, telephone and fiber optics.

Blue = Water

Green = Sewer

Pink = Temporary Survey Markings

White = Proposed Excavation

7.0 PUBLIC ROAD CLOSURE

Although not expected as part of the scope of this RDRA, the Idaho Department of Transportation (IDOT) requires road/lane closures for all work conducted on designated highways, or shoulder areas of designated highways, within the state of Idaho. This includes, but is not limited to, drilling and excavation and other work to be performed along roadways and shoulders. In such a case, it is the responsibility of MWH to contact IDOT for any authorizations. The following information must be submitted with the application:

- Applicant's name, address and phone
- Reason for permit
- Location of work site, including highway number, city, county, milepost or description
- Anticipated commencement and completion of construction/work
- Instructions for new utility installations
- A map of the work area if possible
- A diagram of the type of road closure signs required
- A name and address of the personnel who will close the lane/road

A performance bond may be required by IDOT prior to commencement of work on IDOT property.

STANDARD OPERATING PROCEDURE 2

EQUIPMENT DECONTAMINATION

This SOP has been revised from SOP No. 3 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

STANDARD OPERATING PROCEDURES 3

EQUIPMENT DECONTAMINATION

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1.0 INTRODUCTION

Decontamination of drilling, sampling equipment, monitoring/inspection equipment and support vehicles at the FMC site is a necessary and critical aspect of environmental field investigations. Proper decontamination is a key element in reducing the potential for cross-contamination between samples from different locations, ensuring that samples are representative of the sampled materials, as well as health and safety issues associated with elemental phosphorus. Improper decontamination may result in costly re-collection and re-analysis of samples. All equipment used in the sampling process shall be properly decontaminated prior to the collection of each sample and after completion of sampling activities.

The procedures outlined in this standard operating procedure (SOP) shall be followed during decontamination of field equipment used in the sampling process, including drilling, soil/water sample collection, and monitoring/inspection activities. Any deviations from these procedures shall be noted in the field logbooks and approved by the RDRA Project Manager and the Quality Manager. In addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) and develop their own action-specific Health and Safety Plan (HASP). The Contractor's action-specific HASP must incorporate the general requirements specified in the SWHASP and provide specific health and safety requirements that are pertinent to the anticipated activities during Contractor actions.

Three major categories of field equipment, along with applicable decontamination methods for each, are discussed below.

2.0 DEFINITIONS

Brass Sleeve: Hollow, cylindrical sleeves made of brass and used as liners in split-spoon samplers for collection of undisturbed samples.

Auger Flight: An individual hollow-stem auger section, usually 5 feet in length.

Continuous Core Barrel: 5-foot long steel barrels that can be joined together to allow continuous cores to be collected during a single run.

Drill Pipe: Hollow metal pipe used for drilling, through which soil and groundwater sampling devices can be advanced for sample collection.

Potable Water: A drilling quality water source that can be used for steam cleaning and decontamination water. This source should be sampled at the beginning of each field program to set baseline concentrations.

Distilled Water: Commercially available or laboratory-grade water that has been distilled. Each batch of distilled water should be analyzed to set baseline concentrations. The distilled water will be used as rinse water during the decontamination of tools, sampling equipment and other small items.

Hand Auger: A sampling tool consisting of a metal tube with two sharpened spiral wings at the tip.

Split-Spoon Sampler: A sampling tool consisting of a thick-walled steel tube with a removable head and drive shoe. The steel tube splits open lengthwise when the head and drive shoe are removed.

Scoop: A sampling hand tool consisting of a small shovel- or trowel-shaped blade.

3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Selects project-specific drilling and sampling methods, and associated decontamination procedures with input from other key project staff and other personnel that are responsible for project quality control.

Quality Manager: Performs project audits. Ensures project-specific data quality objectives are fulfilled.

Field Team Leader (FTL) and/or Geologist, Hydrogeologist, or Engineer: Implements the field program and supervises other sampling personnel. Ensures that proper decontamination procedures are followed. Prepares daily logs of field activities.

Field Sampling Technician (or other designated personnel): Assists the FTL, geologist, hydrogeologist, or engineer in the implementation of tasks and is responsible for the decontamination of sampling equipment.

4.0 DECONTAMINATION PROCEDURES

A decontamination pad designed to collect the rinsate and any associated soil or chemicals will be established in a location at the FMC site. The decontamination pad will be constructed in an area designated by FMC and will be used for the duration of the field activities. The decontamination pad will be large enough to accommodate the drilling equipment components that come into contact with contaminated soils or groundwater that are present at the site. The rinsate collected from the decontamination pad and from other onsite decontamination activities will be stored in labeled containers until the proper disposal protocol is established pending waste characterization.

Soil boring drilling and soil sampling procedures require that decontaminated tools be employed in order to prevent cross-contamination. The decontamination procedures described below shall be followed to ensure that only uncontaminated materials will be introduced to the subsurface during drilling and sampling. For equipment and tools that have come into contact with contaminated soils or groundwater, the equipment decontamination process shall be undertaken before and after each use of the equipment and include washing. The flooring of the decontamination pad shall be impermeable to water and have a sump or low area to collect the rinsate to be transferred into the storage containers.

The precise location of the decontamination facility shall be determined based on such factors as ease of access for personnel and proximity to work site and rinsate storage or staging areas.

4.1 DRILLING AND LARGE EQUIPMENT

4.1.1 In Areas with Potential Contact with Contaminated Soil or Groundwater

The following procedures shall be used for decontamination of large pieces of equipment including drilling equipment and support vehicles in areas of the Site in which there is a potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring). This will include percussion hammer drill pipe, hollow-stem auger flights, drill rods for sampling, the drill rig, support vehicles and other equipment and tools that may come in contact with sampling equipment or that may have possible contamination.

- Wash the external surfaces and internal surfaces, as applicable, on equipment using water from an approved water source. If necessary, scrub using a phosphate-free detergent (e.g., Alconox™), or equivalent laboratory-grade detergent until all visible dirt, grime, grease, oil, loose paint, rust, etc., have been removed.
- Rinse with potable water.

4.1.2 In Areas with Little Potential for Contact with Contaminated Soil or Groundwater Contamination

The following procedures shall be used for decontamination of large pieces of equipment including drilling equipment, trenching equipment, construction equipment, and support vehicles in areas of the Site in which there is little or no potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring). Note that this procedure will apply to equipment that comes into contact with native soils and/or slag on slag covered roads or surfaces. For example, trenching in the Western Undeveloped Area and/or construction of the test gamma cap will involve drilling, trenching, digging, or construction activities in areas where the large equipment will only contact native soils and slag on roads and/or construction surfaces.

- Equipment will be decontaminated at the completion of the Site work, prior to removal off-Site, by mechanically brushing tires and other surfaces that came into contact with native soils or slag.

4.2 SOIL AND GROUNDWATER SAMPLING/INSPECTION EQUIPMENT

4.2.1 In Areas with Potential Contact with Contaminated Soil or Groundwater

The following procedure will be used to decontaminate sampling/inspection equipment such as split-spoon samplers; brass sleeves; continuous core barrels; scoops; hand augers; metal sampling pans; video equipment and other sampling/inspection equipment and tools that may come into contact with contaminated soils and/or groundwater.

- Wash and scrub equipment with phosphate-free, laboratory-grade detergent (e.g., Alconox™ or equivalent); steam cleaning may also be performed if possible.
- Double or Triple-rinse with potable water.
- Air dry.
- Store in clean plastic bag or designated casing.

Personnel involved in decontamination activities shall wear appropriate protective clothing as defined in the project-specific health and safety plan.

4.2.2 In Areas with Potential Contact with Elemental Phosphorus

The following procedure will be used to decontaminate sampling/inspection equipment such video equipment and/or sampling equipment and tools that may come into contact with site materials contaminated with elemental phosphorus (P4). The only activity where potential P4 exposure is expected is while video surveying the storm sewers in RA-A. Special health and safety precautions for the storm sewer video survey include:

- Persons involved in the video survey of the RA-A storm sewers should read and be familiar with the hazards of P4 exposure as presented in Section 3.1.3 of the SWHASP. Note that the immediate area around the location where the storm sewer video survey is being performed shall be designated an *Exclusion Zone* as discussed in Section 6.1.1 of the SWHASP.
- Persons involved in the video survey of the RA-A storm sewers, performing decontamination, and within the *Exclusion Zone* shall don ***Modified Level C Protection for Potential Phosphorus Exposure*** as discussed in Section 7.3.3 of the SWHASP.

As the camera and wiring is removed from the storm sewers, the following decontamination procedures will be applied:

- Wash and scrub equipment with water as the camera and wiring is withdrawn from the sewer piping, taking care to only handle the cleaned portion of the equipment (while wearing the ***Modified Level C Protection for Potential Phosphorus Exposure***).
- Double or Triple-rinse with potable water.
- Capture all wash and rinse water in a metal container for later waste determination.
- Air dry the camera and wiring until completely dry. This will allow any remaining P4 to oxidize prior to stowage.

4.2.3 In Areas with Little Potential for Contact with Contaminated Soil or Groundwater Contamination

The following procedures shall be used for decontamination of sampling equipment including in areas of the Site in which there is little or no potential for contact with contaminated soil or groundwater (as determined during the SRI and/or historic groundwater monitoring).

- Equipment will be decontaminated at the completion of the Site work, prior to removal off-Site, by mechanically brushing surfaces that came into contact with native soils or slag.

4.3 GROUNDWATER MONITORING EQUIPMENT

The following procedure shall be used to decontaminate groundwater monitoring devices such as groundwater elevation meters and free product thickness meters. Spray bottles may be used to store and dispense distilled water.

- Wash equipment with laboratory-grade, phosphate-free detergent (e.g., Alconox™ or equivalent) and water, or steam clean.
- Triple-rinse with distilled water.
- Store in clean plastic bag or storage case.

5.0 PROCEDURE FOR OTHER WASTE DISPOSAL

While the decontamination Investigative Derived Waste (IDW) will be evaluated on a case-by-case basis, the general approach to be followed is detailed in SOP-4. Decontamination fluids (typically washwater) will be contained as generated. The washwater will be segregated from solids to the extent practicable (i.e., solids will be allowed to settle out of the washwater on the decontamination containment pad or within the collection container). Washwater will then be containerized to await waste determination. Solids will also be containerized in a separate container to await waste determination.

6.0 REFERENCES

Environmental protection Agency, RCRA Ground-Water Monitoring: Draft Technical Guidance, November 1992. Page 7-17.

STANDARD OPERATING PROCEDURE 3

LOCATION AND TOPOGRAPHICAL SURVEY

This SOP has been revised from SOP No. 6 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

STANDARD OPERATING PROCEDURE 3

LOCATION AND TOPOGRAPHICAL SURVEY

TABLE OF CONTENTS

1.0 INTRODUCTION

Surveying is the science of making the measurements necessary to determine the relative positions of points above, on, or beneath the surface of the earth, or to establish such points. This standard operating procedure (SOP) provides a description of the general types of surveys and requirements for performing these surveys. This SOP describes the applicability of the Global Positioning System (GPS) surveys, along with precision and accuracy required for each technique. This SOP is intended for the project leader to help develop work plans and manage resources. Note that in addition to the minimum requirements outlined in this SOP, all Site contractors must comply with the FMC Site-Wide Health and Safety Plan (SWHASP) while working on Site.

2.0 DEFINITIONS

Accuracy: Accuracy refers to the closeness between measurements and expectations or true values. The farther a measurement is from its expected value, the less accurate it is. Observations may be accurate but not precise if they are well distributed about the expected value, but are significantly disbursed from one another.

Accuracy is often referred to in terms of its order (i.e., first, second, or third order accuracy). The order of accuracy refers to the error of closure allowed; guidelines for each order of accuracy are as follows:

Order of Accuracy	Maximum Error
1st	1/25,000
2nd	1/10,000
3rd	1/5,000

Benchmarks: Monuments placed by surveyors to serve as permanent reference points. Benchmarks are elevation markers, and their location and elevation are precisely established and recorded on surveyors' level notes. They are set upon some permanent object to ensure they remain undisturbed.

Global Positioning System (GPS): This system utilizes a network of overhead satellites orbiting the earth to locate objects and/or targets on the surface of the earth. Data from a minimum of three satellites is required to plot (by triangulation) the location of a certain point. Accuracy is dependent on the duration of data collection and the type of receiver/antenna used. All measurements will be referenced to the State Plane Coordinate System, North American Datum 1983 and North American Vertical Datum 1988.

Monuments: Physical objects that serve as landmarks for navigation. Classes of monuments include: natural, artificial, record, or legal. Examples of natural monuments are trees, large stones, or other substantial, naturally occurring objects in place before the survey was made. Artificial monuments can consist of iron pipe or bar driven into the ground, concrete or stone monument with a drill hole, cross, or metal plug marking an exact location (such as a corner). The standard for monumenting public-land surveys, as adopted by the Bureau of Land Management (BLM), is a post made of iron pipe filled with concrete. The lower end of the pipe is split and spread to form a base and the upper end is fitted with a brass cap with identifying marks. A record monument exists because of a reference in a deed or description (e.g., the gutter along a street). A legal monument is one that is controlling in the description (e.g., "to a concrete post").

Precision: Precision pertains to the distribution over a set of repeated observations of a random variable. It is a measure of the reproducibility of a result or measured value. Thus, if observations are closely clustered together, then the observations are said to have been obtained with high precision. Observations may be precise but not accurate if they are closely grouped about a value that is different from the expected or true value.

Station: A station is a 100-foot section of a measurement from a reference point such as a benchmark. For example, a stake placed 1,500 feet from a reference point is at station 15 and is labeled "15+00," and a stake placed 1,325 from a reference point is labeled "13+25."

3.0 RESPONSIBILITIES

This section presents a brief definition of field roles, and the responsibilities generally associated with them. This list is not intended to be comprehensive and often, additional personnel may be involved. Project team member information shall be included in project specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RD Project Manager: The RDRA Project Manager has overall responsibility for establishing the specific technical requirements and coordinating the survey services for the project. The RDRA Project Manager shall rely on input from FMC personnel and other key project staff who may have more detailed knowledge of the technical requirements and who would be on site to oversee the surveying. To facilitate the management and administration of surveying services procured for a particular site, the RDRA Project Manager may delegate responsibility to the Field Team Leader (FTL) as the focal point for all matters involving surveying services.

Field Team Leader (FTL) and/or Field Geologist, Hydrogeologist, or Engineer: Responsible for implementation of the actual field activities performed on site including the measurement of sampling locations and to daily check the accuracy of the GPS instrument. In addition, the FTL shall be responsible for scheduling and coordinating field activities, overseeing survey activities, and preparing daily logs of field activities.

Surveyor (Surveying Contractor): In the event a licensed land surveyor is needed, the surveyor will be responsible for assuring that all surveying field operations, office calculations, map preparation, and related surveying activities conform to established guidelines and the specific requirements of the surveying subcontract (including health and safety requirements). All surveying operations shall be performed by, or under the direction of, a State of Idaho Licensed (or Registered) Land Surveyor, who shall sign and seal all final drawings, maps, and reports submitted as deliverables.

4.0 GUIDELINES

The following sections provide guidelines for the performance of several types of surveys and the precision and accuracy required for each. Emphasis is placed on the application of surveying techniques to environmental investigations.

4.1 PERFORMING SURVEYS

There are many types of surveys that can be performed. This SOP describes the survey that will potentially be used at the FMC site. The survey will be used to establish northing and easting measurements and an elevation (feet above mean sea level). A Sokkia Axis, Trimble GEO Explorer, Trimble Pathfinder GPS or similar unit will be used for mapping test pits, boreholes, PIC and other sampling locations as well as being used for determining the thickness of soil covers. The selected unit must have an accuracy of 1 meter or less and will be checked daily with a known elevation of a benchmark. If the accuracy is greater than 1 meter, than the type of location data will be evaluated as to whether a professional surveyor is required. All measurements will be referenced to a State Plane Coordinate System, North American datum 1983 and the North American Vertical Datum 1988.

Global Positioning System (GPS) Surveying: GPS is a ranging system from known positions of satellites in space to unknown positions on land, sea, and in air or space. GPS uses the triangulation from orbiting satellites to establish the location derived from the broadcast of a satellite signal. The GPS unit measures the distance using the travel time of radio signals. The GPS concept assumes that four or more satellites will be available at any location on earth 24 hours a day.

Establishing Control (Benchmark): Prior to initiating any type of survey, a control shall be established at the site. The control point will be a surveyed benchmark used as a daily check for the accuracy of the GPS unit. If a benchmark is not available at the site or if access is limited, a fixed monument may be established by a licensed surveyor.

Licensed Surveyor: In the event that a licensed surveyor is required for increased accuracy a State of Idaho Licensed Surveyor will be used at FMC. In the State of Idaho, the Idaho State Government Department of Commerce, Division of Occupational and Professional Licensing, administers licensing and certification programs.

Based on the project requirements, monuments may be set at the site that can be used in future site-surveys as a control point. Care shall be taken when establishing new control points and elevations from other agencies' vertical control points to ensure that all the old control benchmarks are on the same datum or reference plane. The monument shall be stamped with the state planar coordinates and the elevation (feet above mean sea level) such that it shall serve as a reference point for additional surveys. This can save time in future survey work as the surveying contractor will not have to survey new locations from distant established control points.

4.2 REQUIRED ACCURACY AND PRECISION

The required survey accuracy and precision depends on the intended purpose of the survey work. Sampling locations are to be surveyed within 1 meter or less both horizontally and vertically. Higher accuracies may be required for boundary surveys, topographic surveys, etc. The following sections discuss accuracy and precision requirements for specific survey types.

Marking Sampling Locations: The sampling location will be marked in the field using a stake with the corresponding sample number in the event that the location is revisited for additional sampling or surveying.

STANDARD OPERATING PROCEDURE 4

INVESTIGATION DERIVED WASTE MANAGEMENT

This SOP has been revised from SOP No. 7 included in the *SRI Field Sampling Plan for the FMC Plant OU – May 2007*.

STANDARD OPERATING PROCEDURE 4

INVESTIGATION DERIVED WASTE (IDW) MANAGEMENT

TABLE OF CONTENTS

1.0 INTRODUCTION

Investigation-derived waste (IDW) may be generated during the field investigation activities conducted under the planned extraction zone hydrogeologic study at the FMC Plant Operable Unit during 2014. The National Contingency Plan (NCP), codified in 40 Code of Federal Regulations (CFR) 300, requires that IDW be handled to attain all the applicable or relevant and appropriate requirements (ARARs) to the extent practicable, considering the urgency of the situation. The purpose of this SOP is to present procedures to be followed in the management of IDW generated during these field activities.

Potential IDW that may be generated during field activities are solid wastes and may include (but are not limited to) the following media and waste types:

Fluids	Solids
Groundwater well development / purge	Soils and soil cuttings
Drilling mud	Plastic tarps or sheeting
Grout	Drill pipe and well casing/screen
Decontamination fluids and wastewater	Decontamination solids
	Disposable equipment (i.e., rope, bailers, sampling equipment, & other consumables)
	Spent personal protective equipment (PPE)
	Used containers, sample bottles
	Packaging materials

The above wastes may or may not be encountered, generated or managed while performing the 2014 field activities. However, all solid waste streams will be characterized to determine if they are hazardous wastes per 40 CFR § 262.11 for the purposes of handling and disposal. Guidance from this document shall be used as part of project planning to estimate total volumes of IDW likely to be generated during the anticipated 2014 field activities as well as how the IDW will be managed and disposed.

2.0 DEFINITIONS

Area of Contamination (AOC) unit: The AOC unit concept is critical to the IDW management at a CERCLA investigation site. Although EPA has not promulgated a definition of an AOC unit, an AOC unit is generally an area within a CERCLA investigation site with similar characteristics with respect to contamination and the associated risks to human health and the environment. A CERCLA investigation site may contain one or more AOC units. AOC units for the FMC Plant Operable Unit, which may be different from the Remediation Units (RUs) as used in the *SRI Work Plan for the FMC Plant OU* and/or the Remediation Areas (RAs) used in the *SFS Report for the FMC Plant OU*, will be delineated based upon exiting information, information gathered during the SRI, and visual observation as well as consideration of IDW management.

Decontamination fluids: Any fluids, including aqueous wash water, solvents, and contaminants that are used or generated during decontamination procedures.

Decontamination solids: Any solids, including soils and soil cuttings, fill materials, and contaminants that are generated during decontamination procedures.

Grout: A fluid mixture of cement and water (neat cement) of a consistency that can be forced through a pipe and placed as required.

Hazardous waste: A solid waste that meets the definition of a hazardous waste under RCRA as defined in 40 CFR § 261.3.

Hazardous IDW: An investigation derived waste that is also a hazardous waste under RCRA as defined in 40 CFR § 261.3.

Investigation-derived waste (IDW): Solid wastes, as defined in 40 CFR § 261.2, directly generated as result of performing the 2014 field activities at the FMC Plant OU.

Nonhazardous waste: A solid waste that does not meet the definition of a hazardous waste as defined in 40 CFR § 261.3 or is excluded from hazardous waste regulation per 40 CFR § 261.4(b).

Soils and soil cuttings: Solid material generated from excavation or drilling processes. Soils may include native soils, fill materials, and/or other historical plant waste streams used as fill materials on the site.

Solid waste: Any waste stream (solid, liquid or containerized gas) that meets the definition of solid waste under RCRA as defined in 40 CFR § 261.2.

3.0 RESPONSIBILITIES

This section presents a brief definition of the field team roles and responsibilities for management of IDW generated while conducting the 2014 field activities. This list is not intended to be a comprehensive list as additional personnel may be involved. Project team member information shall be included in project-specific plans (e.g., work plan, field sampling plan, quality assurance plan, etc.), and field personnel shall always consult the appropriate documents to determine project-specific roles and responsibilities. In addition, one person may serve in more than one role on any given project.

RDRA Project Manager: Responsible to ensure that all field team members are properly trained per their responsibilities associated with IDW and that appropriate equipment and facilities are available for appropriate IDW management.

Field Team Leader (FTL): Implements the field program and supervises all field team members in the appropriate management of IDW. Ensures that only properly trained personnel are managing IDW on the site.

Environmental, Health and Safety (EHS) Officer: Assists the Field Team Leader in the supervision of all IDW management on site. The EHS officer shall be responsible for all IDW identification and characterization, on site disposal, off site shipment and disposal, waste accumulation, emergency response and contingency planning, IDW training, and IDW reporting and recordkeeping.

Project Team Members: Ensure that they are properly trained prior to any IDW management as well as follow the appropriate IDW procedures and training.

4.0 REGULATORY BASIS AND GUIDANCE

IDW encountered, generated, or managed during the 2014 field activities may contain hazardous substances as defined by CERCLA. Some IDW may be hazardous wastes under RCRA while others may be regulated under other federal laws such as TSCA. These regulatory requirements may be applicable or relevant and appropriate requirements (ARARs) which impact how the IDW is managed. Note that hazardous wastes under RCRA and/or wastes regulated under TSCA are not expected to be encountered, generated, or managed as part of the 2014 field activities. However, waste determinations will be performed and documented on all waste streams.

4.1 EPA GUIDANCE ON IDW MANAGEMENT

The management of IDW generated during the 2014 field activities shall be in accordance with EPA Guidance "Management of Investigation-Derived Wastes During Site Inspections", May 1991 (EPA, 1991). This guidance is based upon EPA's strategy for managing IDW based upon the following concepts:

- The National Contingency Plan (NCP) directive that CERCLA site investigations (SI) comply with applicable or relevant and appropriate requirements (ARARs) to the extent practicable.

- The Area of Contamination (AOC) unit concept.

The specific elements of EPA's guidance for IDW management are as follows:

- Characterizing IDW through the use of existing information (manifests, MSDSs, previous test results, knowledge of the waste generation process, and other relevant records) and best professional judgement.

- Delineating an AOC unit for leaving RCRA hazardous soil cuttings within the unit.

- Containerizing and disposing of RCRA hazardous groundwater, decontamination fluids, PPE, and disposable equipment at RCRA Subtitle C facilities.

- Leaving on-site RCRA nonhazardous soil cuttings, groundwater, and decontamination fluids preferably without containerization and testing.

In general, EPA does not recommend removal of wastes from sites, in particular, from those sites where IDW do not pose any immediate threat to human health or the environment. Actions taken during the 2014 field activities with respect to IDW, that leave conditions essentially unchanged, should not require a detailed analysis of ARARs or assurance that conditions at the site will comply with the ARARs. At the same time, field personnel conducting the 2014 field activities should ensure that their handling of IDW does not create additional hazards at the site.

In brief, compliance with the NCP can generally be assured by:

1) Identifying contaminants, if any, present in the IDW based upon existing information and best professional judgement; testing is not required in most circumstances.

2) Determining ARARs and the extent to which it is practicable to comply with them.

3) Delineating an AOC unit based upon existing information and visual observation if soil cuttings are RCRA hazardous.

4) Burying RCRA hazardous soil cuttings within the AOC unit, so long as no increased hazard to human health and the environment will be created. Containerization and testing are not required.

5) Containerizing RCRA hazardous groundwater and other RCRA hazardous IDW such as PPE, disposable sampling equipment, and decontamination fluids for off-site disposal.

4.2 HAZARDOUS WASTE REGULATION

The RCRA hazardous waste regulations are clearly ARARs for hazardous IDW generated and managed during the 2014 field activities. However, with the application of EPA IDW guidance, RCRA requirements apply to management of IDW in the following manner:

- If RCRA hazardous IDW is stored or disposed off-site, then comply with all RCRA (and other ARAR) requirements.

- If RCRA hazardous IDW is stored on-site, then comply with RCRA (and other ARAR) requirements to the extent practicable.

For the 2014 field activities, the following general guidance is expected to be practicable and therefore followed, recognizing that each situation will be evaluated against EPA IDW guidance (EPA, 1991) as well as RCRA hazardous waste requirements and other ARARs:

- IDW may be assumed not to be a “listed” hazardous waste under RCRA 40 CFR 261 Subpart D, unless available information about the site suggests otherwise.

- IDW characterization to determine if the IDW exhibits RCRA hazardous waste characteristics do not typically require testing if the characterization can be made by “applying knowledge of the hazardous characteristics in light of the materials or processes used” or by historical testing consistent with 40 CFR § 262.11(c).

- Compliance with the RCRA hazardous waste generator requirements of 40 CFR Part 262 for all RCRA hazardous IDW generated and/or managed (with exception of soil cuttings managed in accordance with the EPA IDW guidance). It is presumed that the RCRA hazardous IDW generated will fall within the large quantity generator (LQG) requirements.

- Land disposal does not occur (and thus the Land Disposal Restrictions [LDR] of 40 CFR Part 268 are not applicable) when IDW soil cutting wastes are:

  - Moved, stored or left in place within a single AOC unit;
  - Capped in place;
  - Treated in situ (without moving the IDW to another AOC unit for treatment); or
  - Processed within the AOC unit to improve structural stability (without placing the IDW into another AOC unit for processing).

- Conversely, land disposal does occur (and the LDR of 40 CFR Part 268 are applicable) when IDW soil cutting wastes are:

  - Moved from one AOC unit to another AOC unit for disposal;
  - Moved outside an AOC unit for treatment or storage and returned to the same AOC unit for disposal;
  - Excavated from an AOC unit and placed in a container, tank, surface impoundment, etc. and then re-deposited back into the same AOC.

5.0 DESCRIPTION OF ANTICIPATED IDW MANAGEMENT

The following subsections provide a description of the anticipated IDW to be encountered, generated, and/or managed at the FMC Plant Operable Unit during the 2014 field activities and the anticipated management of each. It should be noted that this information is provided for planning purposes, and will be evaluated and may need to be revised based upon actual experience and waste determinations while on site.

5.1 SOIL AND SOIL CUTTINGS

During the 2014 field activities, numerous test pits, trenches, and borings will be performed within the Western Undeveloped Area (WUA) of the FMC Plant Operable Unit to gain access to appropriate depths for soil sampling and to provide a source of clean soil for the test gamma cap. The WUA was determined during the SRI to be un-impacted, therefore, soils from this area will be managed as clean soils. There will also be extraction wells and sampling wells installed at the northeast corner of the FMC Plant OU. In addition to native soils, fill materials including slag and phosphate ore are expected to be encountered. Past analyses of these fill materials have determined that these fill materials do not demonstrate any characteristics of a hazardous waste, and therefore would not be hazardous.

Therefore, all soil and soil cuttings managed during the 2014 field activities will be managed as follows unless field observations are different than expected:

- Leaving on-site RCRA nonhazardous soil cuttings within the AOC where they are generated. Typically, this will involve placing soil cuttings back into the same investigation pit, trench, or bore hole (except finished wells) and in the same order from which the material was removed, to the extent practicable. For example, and effort will be made to segregate fill materials from native soils as soil cuttings are removed from a pit, trench, or bore hole. For finished wells, the soil cuttings will be spread out at the surface near the bore hole. The placement of the soil cuttings back into the pit, trench or bore hole will typically involve placement of the native soils back first, followed by the fill materials. This should ensure that there are not additional hazards created at the site and that site conditions remain essentially unchanged.

5.2 WELL DEVELOPMENT AND PURGE FLUIDS

During the 2014 field activities, groundwater extraction wells and piezometers are anticipated to be installed in the northeast area of the FMC Plant Site. Fluids will be generated during the development of the wells and piezometers and purge water will be generated during the planned pump testing of the extraction wells. During the over 20 years of groundwater monitoring at the FMC OU, including sampling from approximately 125 monitoring wells at the FMC OU, over 4,500 samples and over 50,000 individual analytical results, no groundwater sample result has ever exceeded the threshold values for RCRA characteristic waste, and therefore, based upon process knowledge and consistent with the requirements of 40 CFR §262.11, the liquid IDW generated during the development of the wells and piezometers and the pump testing would not be hazardous.

Well development and purge fluids (liquid IDW) generated during the field activities will be managed as follows unless field observations are different than expected:

- Liquid IDW will be characterized based on analysis of development fluids from each extraction well and piezometer which will be separately containerized in a portable container(s) as generated, and held pending waste determination.

- As a confirmation of the extensive existing groundwater data set described above, a sample of well development fluids from each new well and piezometer will be collected and analyzed for pH and the eight RCRA metals.

- Liquid IDW that is determined to be nonhazardous will be transferred from the portable container(s) to a water truck(s) and utilized for dust control on-site.

- Subsequently generated liquid IDW (e.g., well purge [aquifer pump test] fluids) will be characterized through the use of existing information (extensive existing data set described above, well development fluid characterization described above, knowledge of the contaminants present, and other relevant records) and best professional judgment as consistent with the requirements of 40 CFR §262.11. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- Subsequently generated liquid IDW that are determined to be nonhazardous will be loaded directly from the well pump (or booster pump if needed) directly into water trucks for dust control on the site. For dust control, the approximately 1.5 million gallons of water that will be pumped over an approximately one week period during the aquifer testing would represent a total of about 0.014 inches (or about 0.003 inches per day) of water spread over about a 340 acre area of the plant site (site-wide roadways and areas within RA-A).

- Any well which produces liquid IDW that is determined to be hazardous will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

5.3 SPENT SAMPLING-RELATED EQUIPMENT

During the 2014 field activities, spent sampling-related equipment may be generated. This may include (but not limited to) plastic sheeting/tarps, rope, bailers, sampling equipment, spent PPE, sample bottles, used containers, packaging materials, and other consumables. The spent sampling-related equipment is expected to be nonhazardous, based upon historical and SRI data collected.

While the spent sampling-related equipment will be evaluated on a case-by-case basis, the general approach to be followed for spent sampling-related equipment IDW will follow the EPA guidance for IDW (EPA, 1991) which includes:

- Containerizing the spent sampling-related equipment at the point of generation.

- Characterizing the spent sampling-related equipment IDW through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- Those spent sampling-related equipment IDW that are determined to be nonhazardous will be disposed along with other Site non-hazardous solid waste.

- Those spent sampling-related equipment IDW that are determined to be hazardous (although not expected) will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

5.4 DECONTAMINATION FLUIDS AND SOLIDS

5.4.1 Decontamination Fluids and Solids Associated with Drilling, Digging, and/or Trenching

During the 2014 field activities, decontamination fluids and solids will be generated. Typically, these will be generated at a common decon area, although there may be more than one decon area. Typically, the decontamination IDW will include (but not limited to) washwater from equipment, cleaning agents, cleaning utensils, and spent PPE (along with associated contaminants). Although this decontamination IDW is expected to be nonhazardous, waste determinations will be performed on each waste stream.

5.4.2 Decontamination Fluids and Solids Waste Management

While the decontamination IDW will be evaluated on a case-by-case basis, the general approach to be followed for decontamination IDW will follow the EPA guidance for IDW (EPA, 1991) which includes:

- Containment of decontamination fluids (typically washwater) as generated. The washwater will be segregated from solids to the extent practicable (i.e., solids will be allowed to settle out of the washwater on the decontamination containment pad). Washwater will then be containerized to await waste determination. Solids will also be containerized in a separate container to await waste determination.

- Other decontamination solids such as cleaning utensils and PPE will also be containerized to await waste determination.

- Characterizing the decontamination IDW through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records) and best professional judgement. This characterization will be documented and maintained as part of the solid/hazardous waste determination records.

- The decontamination solids IDW that are determined to be nonhazardous will be disposed in on-site.

- The decontamination liquids IDW that are determined to be nonhazardous will be disposed as a nonhazardous solid waste, preferably on-site.

- The decontamination IDW (either liquid or solid) that are determined to be hazardous will be managed per the procedures presented in Section 6.0 below and disposed in an off-site RCRA facility.

6.0 PROCEDURES FOR HAZARDOUS IDW MANAGEMENT

Although hazardous IDW is not expected to be generated, the following procedures apply to all IDW that have been determined to be hazardous except for soil cuttings IDW that remain with the AOC unit.

6.1 INTRODUCTION

Once an IDW has been determined to be hazardous, the federal RCRA Subtitle C waste management requirements apply to that waste. The scope of this procedure covers the requirements for large quantity generators of hazardous IDW which manage the hazardous IDW on site such that RCRA permitting is not required.

6.2 DETERMINE LAND DISPOSAL RESTRICTIONS

The 1984 amendments to the RCRA law included a prohibition of land disposal of certain hazardous wastes without first meeting some treatment standards. For the most part, all listed and characteristic hazardous wastes must be treated according to the treatment levels and technologies outlined in 40 CFR Part 268 to reduce the toxicity and/or mobility of hazardous constituents prior to being disposed of on the land, i.e., landfilled. Therefore, a generator must determine if the waste is a "restricted waste" under the land ban rules, and if so, off site treatment and disposal is limited. Note that these rules apply only to wastes destined for land disposal which is defined as: placement in or on the land including a landfill, surface impoundment, waste pile, injection well, land treatment facility, salt dome formation, salt bed formation, underground mine or cave, or concrete vault or bunker. Wastes which are shipped off site for disposal other than land disposal are not regulated under the land disposal restriction regulations of 40 CFR Part 268.

Generators of hazardous wastes must determine if the waste is restricted from land disposal under 40 CFR Part 268. The following reporting and recordkeeping requirements apply.

- If a generator determines that he is managing a restricted waste and the waste does not meet the applicable treatment standards, with each shipment of waste, the generator must notify the treatment or storage facility in writing of the appropriate treatment standards;
- If the generator determines that he is managing a restricted waste and the waste can be disposed without further treatment, with each shipment of waste, the generator must submit to the treatment, storage or disposal facility a notice and certification stating that the waste meets the applicable treatment standards;
- If the generator determines that he is managing a waste subject to an exemption from a prohibition on the type of land disposal method utilized for

the waste, with each shipment of waste, the generator must submit to the receiving facility a notice stating that the waste is not prohibited from land disposal;

- If the generator is managing prohibited waste in tanks, containers, or containment buildings regulated under 40 CFR 262.34, and is treating such waste in such tanks, containers, or containment buildings to meet applicable treatment standards, the generator must develop a waste analysis plan which describes the procedures the generator will carry out to comply with the treatment standards; and
- If the generator determines whether the waste is restricted based solely on his knowledge of the waste, all supporting data used to make this determination must be retained on-site in the generator's files.

The generator must retain on-site a copy of all notices, certifications, demonstrations, waste analysis data, and other documentation produced pursuant to these requirements for at least three years from the date the waste was last shipped from the site. It should also be noted that it is prohibited to dilute a hazardous waste in order to circumvent the land disposal prohibitions (40 CFR 268.3). Once a waste is determined to be a "restricted waste", an appropriate Treatment, Storage, and Disposal Facility (TSDF) can be selected to properly treat and dispose of the waste.

6.3 ON-SITE ACCUMULATION

As discussed in Section 5.0 above for each IDW generated, a large quantity generator (LQG) must make the appropriate hazardous waste determination per 40 CFR Part 262.11. If the IDW is determined to be hazardous, then the IDW will typically be stored on-site prior to shipment off-site for disposal. The following requirements apply to all hazardous IDW being stored on-site prior to shipment.

6.3.1 EPA Identification Number (40 CFR Part 262.12)

Any facility which is a LQG of hazardous wastes must not treat, store, dispose, transport or offer for transportation any hazardous waste without first obtaining a EPA identification number from EPA (or the authorized state). Hazardous wastes cannot be offered to transporters or to treatment, storage or disposal facilities that have not received a EPA identification number. The FMC Plant Operable Unit has an EPA ID number of IDD070929518 which will be used on all manifests for shipments of hazardous IDW for off-site disposal.

6.3.2 On-Site Hazardous Waste Accumulation (Storage) (40 CFR 262.34(d))

Two types of accumulation areas for hazardous waste are permissible for a LQG without RCRA interim status or a Part B permit. These are the "90-day storage area" and the "satellite accumulation station" (SAS). The SAS requirements are discussed below. With regards to a "90-day storage area", a LQG may store hazardous wastes on-site for up to 90 days or less in a storage area, provided that the following conditions are met:

- If the waste is placed in containers, the requirements of 40 CFR Part 265 Subpart I (container requirements) are met. See below for container requirements;
- If the waste is placed in tanks, the requirements of 40 CFR 265 Subpart J (tank requirements) are met. See below for the tank requirements.
- At closure, the generator closes the storage area per the requirements of 40 CFR 265.111 and 40 CFR 265.114;
- The date which the hazardous waste is placed in the storage area is clearly marked on the container, and the container is clearly marked as "Hazardous Waste";
- The facility complies with 40 CFR Part 265 Subpart C, Preparedness and Prevention (See Section 6.3.3 below);
- The facility complies with 40 CFR Part 265 Subpart D, Contingency Plan and Emergency Procedures (See Section 6.3.4);

- The facility complies with 40 CFR Part 265.16 training requirements (See Section 6.6 below);
- Any hazardous wastes which are stored longer than 90 days must first be granted an extension by EPA (or authorized state).

90-Day Storage Area Container Requirements (40 CFR Part 265 Subpart I)

Hazardous waste stored in containers must meet the following requirements:

- Containers must be in good condition, free of leaks;
- Hazardous wastes must be compatible with container (or liner) material;
- Containers must always be kept closed except to add or remove wastes;
- Containers must be handled in a manner to avoid ruptures;
- The storage area must be inspected at least weekly to check for container deterioration; and
- Incompatible wastes must be stored separately with separate secondary containment.

Incompatible wastes are wastes that are unsuitable for co-mingling because the co-mingling could result in any of the following:

- Extreme heat or pressure generation;
- Fire;
- Explosion or violent reaction;
- Formation of substances that have the potential to react violently;
- Formation of toxic dusts, mists, fumes, gases, or other chemicals; and/or
- Volatization of ignitable or toxic chemicals due to heat generation.

90-Day Storage Area Tank Requirements (40 CFR Subpart J)

LQGs that accumulate or store hazardous wastes in tanks or tank systems must meet the following requirements:

- For tanks existing prior to July 14, 1986, an assessment of tank must be performed and certified by an independent, qualified, licensed engineer. The written certification must be kept on file at the facility (40 CFR 265.191);
- New tank systems (those built after July 14, 1986) must meet tank technical standards and have been certified by an independent, qualified, licensed engineer. The written certification must be kept on file at the facility (40 CFR 265.192);
- New tank systems must have adequate secondary containment and leak detection systems. Existing tanks must be upgraded to meet these standards by the time the tank is 15 years of age (40 CFR 265.193);
- Tanks must be operated to prevent system failure, overflow and spills. Tanks must be operated with sufficient freeboard to prevent overtopping (40 CFR 265.194);
- Inspect the tanks at least once each operating day for the following:
    - Discharge control equipment;
    - Monitoring equipment and controls;
    - Tank level; and
    - Evidence of leaks or spills. (40 CFR 265.195)
- Inspect the tanks at least weekly for corrosion, erosion or leaks;
    - The tank must meet the closure and post-closure care provisions of 40 CFR 265.197; and
    - Store incompatible wastes separately (40 CFR 265.199).

Satellite Accumulation Station (SAS) Requirements (40 CFR 262.34(c))

A SAS is a container placed at or near the point of waste generation for the purpose of collecting the waste as it is being generated. For example, a container may be placed in the quality control laboratory for collection of hazardous wastes generated in the laboratory. This SAS may collect up to 55 gallons of hazardous waste or 1 quart of acute hazardous waste. The SAS does not need to meet the requirements of a storage area, provided the following conditions are met:

- The amount of hazardous waste accumulated at the SAS does not exceed 55 gallons (or 1 quart of acute hazardous waste);
- The SAS is located at or near the point of generation where the waste is initially accumulated and is under the control of the operator of the process generating the waste;
- The container used is in good condition, is compatible with the wastes being accumulated, and is kept closed except to add or remove wastes;
- The container is marked with the words "Hazardous Waste" or other words to identify the contents; and
- Once the 55-gallon limit is reached, the date is marked on the container and the container is moved from the SAS within three days to a proper location. For example, the wastes must either be moved to the storage area or be picked up by a waste transporter and moved off-site.

6.3.3 Preparedness and Prevention (40 CFR Part 265 Subpart C)

The following preparedness and prevention steps must be taken concerning the hazardous waste storage area:

- The storage area must be operated and maintained to minimize the possibility of fire, explosions or releases of hazardous waste;
- The facility must have appropriate communication systems, fire-fighting equipment, spill control equipment and decontamination equipment;
- All emergency response systems and equipment must be tested monthly with documentation and maintained to assure proper operation;
- Persons handling hazardous wastes must have immediate access to alarms and/or communication systems;

- The storage area shall have adequate aisle space for emergency response activities; and
- The facility must attempt to make arrangements with the local police, fire departments, emergency response teams, and local hospitals to assure readiness for potential emergencies associated with the storage area.

6.3.4 Contingency Plan and Emergency Procedures (40 CFR Subpart D)

A LQG that accumulates or stores hazardous waste on site in a 90-day storage area must develop and keep current a contingency plan for the facility. The purpose of the contingency plan is to provide an organized plan of action and delegation of responsibilities and authority to specific facility personnel to respond to emergency situations that may require both the facility and/or outside resources. The contingency plan is designed to minimize hazards to humans or the environment from fires, explosion or any unplanned sudden or non-sudden release of hazardous waste/hazardous waste constituent to air, soil or surface water in compliance with the requirements of 40 CFR 265 Subpart D. MWH will maintain a Contingency Plan on the site if hazardous IDW are accumulated on-site.

The key components of the contingency plan include the following (40 CFR 265.52):

- A description of the emergency response organization, including designation of the Emergency Coordinator and alternates;
- Response procedures;
- Emergency notification;
- Arrangements with local authorities;
- List of names, addresses and phone numbers of designated emergency personnel and alternates;
- List of emergency response communication equipment and locations;
- Evacuation procedures, routes and alternates; and

- Procedures for amending the plan.

Copies of the plan must be sent to (40 CFR 265.53):

- The FMC Project Manager;
- Power County Sheriff's department;
- Pocatello fire department; and
- Other agencies as deemed appropriate.

The emergency coordinator (EC) is the key person facilitating emergency preparedness and response. The EC or designated alternate shall be on-site or on-call at all times. The EC and alternates must be trained and thoroughly familiar with the contingency plan, emergency response activities and operation of the facility. The EC must know the locations and characteristics of all waste generated, location of all records within the facility and the facility layout. The EC must have the authority to commit the resources needed to carry out the spill response plan. Any person or department who first discovers any spill of a hazardous waste/material is responsible for notifying the spill response/emergency response coordinator. The EC for the 2014 field activities will be the EHS Officer with the Field Team Leader and the RDRA Project Manager as alternates.

The contingency plan should be reviewed and immediately amended when:

- Changes in applicable regulations occur;
- The plan fails in an emergency;
- Changes are made to emergency procedures;
- Changes occur in emergency personnel list; or
- Changes occur in emergency equipment list.

6.4 PRE-TRANSPORTATION REQUIREMENTS

Prior to transporting hazardous wastes or offering hazardous wastes for transportation off-site, the generator must comply with the following:

- Package the hazardous wastes in DOT-approved containers per 49 CFR Parts 173, 178 and 179. DOT-approved containers (such as drums) are usually marked as being DOT-approved);
- Label the hazardous wastes according to DOT labeling requirements per 49 CFR Part 172;
- Mark each container (of 110 gallons or less) used in transportation with the following:

  HAZARDOUS WASTE - Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the EPA.

  - Generator's Name and Address
  - Manifest Document Number
- Ensure that the initial transporter placards the transport vehicle with the appropriate placard in accordance with 49 CFR Part 172 Subpart F.

6.5 MANIFESTING OFF-SITE SHIPMENTS OF HAZARDOUS IDW

Any generator which transports or offers for transportation hazardous waste for off-site treatment, storage or disposal must prepare a manifest according to manifest instructions for each shipment of similar hazardous wastes. The manifest must be carefully filled out with each shipment. Take care to follow the instructions and use the terms as listed in the instructions. A generator must designate on the manifest one facility (designated facility) which is permitted to handle the waste described on the manifest (40 CFR 262.20).

The generator must determine if the state to which the wastes are destined (consignment state) requires use of its own manifest. If so, then the consignment state's manifest must be used. If the consignment state does not require use of its manifest, and the state in which the waste shipment originates (generator state) does, then the manifest from the generator state must be used. If both states have manifests, use the consignment state manifest, making sure that there are sufficient copies to meet the generator state distribution requirements. If neither state requires use of its manifest, then any uniform hazardous waste manifest may be used (40 CFR 262.21).

The manifest must contain at least enough copies such that the generator gets two copies, the transporter gets one copy and the designated facility gets one copy. Some states require additional copies to be sent to the state. At the time of shipment, the generator must keep one copy (the generator copy) of the completed, signed manifest and give the remaining copies to the transporter. Each copy must have the signature of the generator and the transporter at the time of shipment. The original manifest shall be returned to the generator once the shipment reaches the designated facility and the manifest is signed by the designated facility (40 CFR 262.21).

If the original, signed manifest is not received by the generator within a certain number of days, action by the generator is required. These requirements are discussed in the following sections:

- If, after 35 days from the date of shipment, the original manifest copy is not yet received by the LQG, the LQG must contact the transporter and/or the designated disposal facility to determine the status of the hazardous waste (40 CFR 262.42(a)(1)).
- If after 45 days from the date of shipment, the original manifest copy is not yet received by the LQG, the LQG must submit an exception report to the U.S. EPA (or authorized state). The exception report must include a copy of the manifest along with an explanation of efforts to locate the hazardous wastes and the result of these efforts (40 CFR 262.42(a)(2)).

6.6 PERSONNEL TRAINING

Any person, and their immediate supervisor(s), involved in waste management at a LQG facility which stores hazardous waste in a 90-day storage area must undergo initial and annual training for hazardous waste management (40 CFR 262.34(a)(4) and 40 CFR 265.16). Facility personnel are required to successfully complete a program of classroom instruction or on-the-job training that teaches them to perform hazardous waste management duties relevant to their jobs. The program must be directed by a person trained in hazardous waste management procedures.

The training must be designed to enable personnel to effectively respond to emergencies by becoming familiar with emergency procedures, emergency equipment and emergency systems, including the following;

- Procedures for using, inspecting, repairing and replacing facility emergency and monitoring equipment;
- Communications or alarm systems;
- Response to fires or explosions; and
- Off-site communication.

Employee training is to be held at regular intervals. Emergency planning information, e.g., the Contingency Plan, also should be provided to state and local emergency response agencies at regular intervals (40 CFR 265.37 and 265.53). Employees required to receive the training cannot work unsupervised until they have completed the training requirements (either classroom or on-the-job training). In addition, facility personnel must take part in an annual review of the initial training.

The following records must be maintained at the facility for employees affected by this training:

- Job title for each position and name of employee filling each job;
- Job descriptions for each position related to hazardous waste management;

- Written description of type and amount of initial and continuing training that will be given to each person filling the various job positions; and
- Documentation that necessary training has been given and completed by each affected personnel.

Training records are required to be kept on current personnel until closure of the facility. For former employees, training records must be kept for at least three years from the date the employee last worked at the facility and may be transferred if the employee stays within the same company (40 CFR 265.16(e).

6.7 REPORTING AND RECORDKEEPING

The following reports are required of a LQG:

- Manifest exception reports as discussed in Section 6.5 above.
- A LQG must submit a Biennial Report to the EPA (or authorized state) every even numbered year by March 1, e.g., March 1, 2008 for the 2007 reporting year. The Biennial Report is to be submitted on EPA form 8700-13A.

The following records are required to be kept for a minimum of three years by the LQG:

- The signed original manifests;
- Biennial reports;
- Exception reports;
- All records pertaining to hazardous waste determinations; and
- Land disposal determination records, notification and certification records.

7.0 REFERENCES

EPA, 1991. Management of Investigation-Derived Wastes During Site Inspections, EPA May 1991, EPA/540/G-91/009

APPENDIX E

Referenced EMF RI Table and Figures

TABLE 3.3-1

TABLE 3.3-1

HYDRAULIC CONDUCTIVITIES AND TRANSMISSIVITIES OF EMF AQUIFER SYSTEM

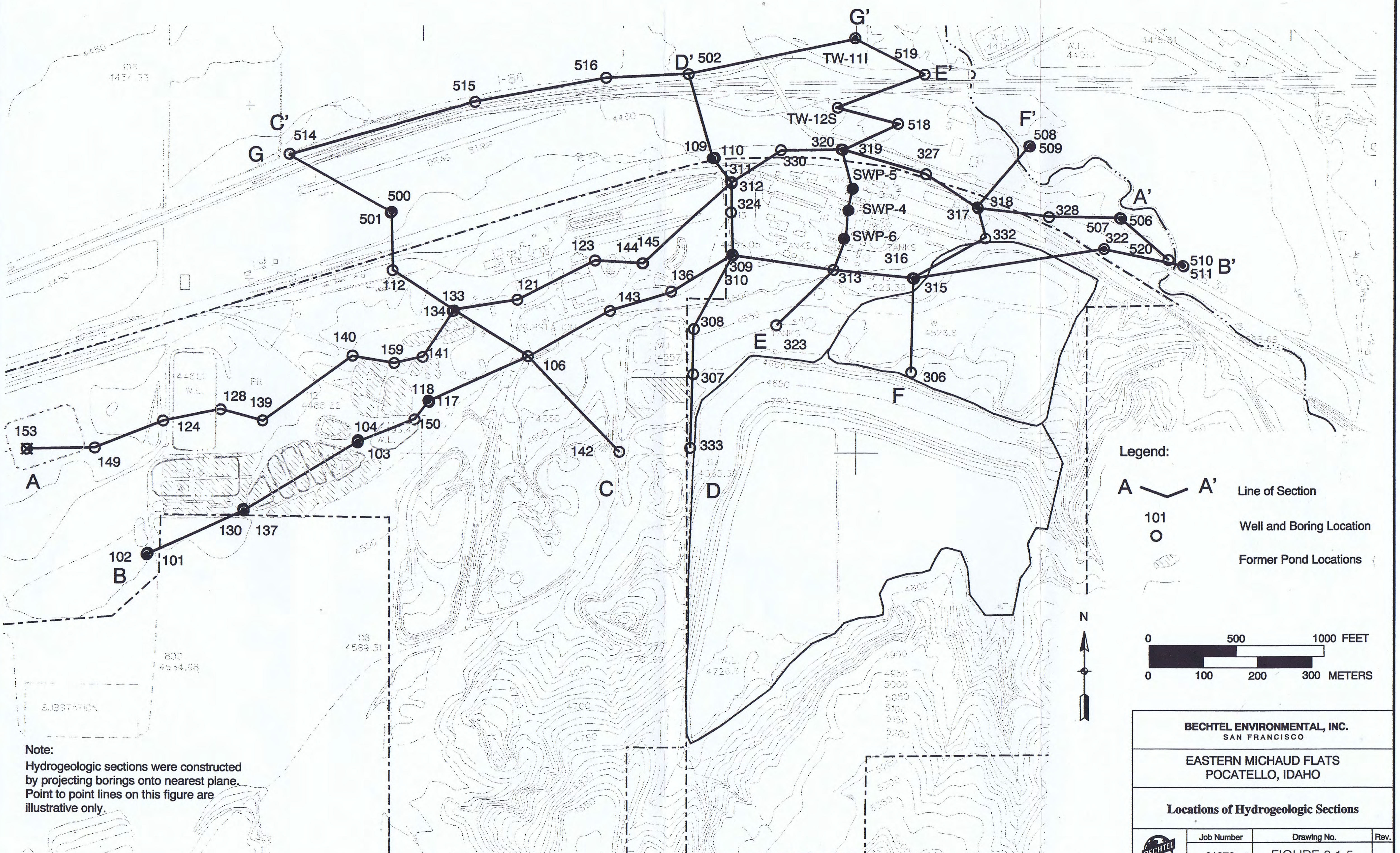
	Shallow Wells	Hydraulic Conductivity cm/s	Hydraulic Conductivity ft/day	Type of Test	Source
MICHAUD FLATS	104	4.45E-02	126	Slug Test	BEI
	108	1.01E-01	286	Slug Test	BEI
	110	3.80E-02	108	Slug Test	BEI
	111	1.40E-01	397	Slug Test	BEI
	113	1.40E-01	397	Pumping Test	BEI
	126	5.85E-02	166	Slug Test	BEI
	134	1.09E-01	309	Slug Test	BEI
	135	3.15E-02	89.3	Slug Test	BEI
	139	1.90E-02	53.9	Slug Test	BEI
	140	9.70E-02	275	Slug Test	BEI
	146	6.10E-02	173	Slug Test	Hydrometrics
	148	2.45E-02	69.5	Slug Test	Hydrometrics
	150	3.55E-01	1000	Pumping Test	BEI
	153	3.30E-01	935	Slug Test	BEI
	154	1.74E-02	49.3	Slug Test	Hydrometrics
	501	9.05E-02	257	Slug Test	BEI
	514	3.92E-02	111	Slug Test	Hydrometrics
	515	1.05E-02	29.8	Slug Test	Hydrometrics
	516	2.33E-02	66.0	Slug Test	Hydrometrics
BANNOCK RANGE	106	4.30E-03	12.2	Slug Test	Hydrometrics
	142	7.00E-04	1.98	Slug Test	BEI
	300	2.43E-04	0.69	Slug Test	Hydrometrics
	301	1.00E-05	0.03	Slug Test	BEI
	304	4.95E-04	1.41	Slug Test	Hydrometrics
	306	1.17E-03	3.32	Slug Test	Hydrometrics
	307	9.91E-02	281	Slug Test	Hydrometrics
	308	2.51E-02	71.2	Slug Test	Hydrometrics
	313	1.80E-02	51.0	Slug Test	BEI
	316	1.02E-02	28.9	Slug Test	BEI
	323	1.20E-03	3.40	Slug Test	Hydrometrics
	325	5.45E-03	15.5	Slug Test	BEI
	333	9.91E-03	28.1	Slug Test	Hydrometrics
	PEI-2	1.00E-03	2.83	Pumping Test	PEI
	PEI-5	4.50E-04	1.28	Pumping Test	PEI
PORTNEUF RIVER	312	1.40E+00	3970	Pumping Test	BEI
	318	1.40E-03	3.97	Slug Test	BEI
	324	5.45E-02	154	Slug Test	BEI
	327	1.18E-01	334	Slug Test	Hydrometrics
	328	1.84E-01	522	Slug Test	Hydrometrics
	502	1.39E-01	394	Slug Test	Hydrometrics
	503	1.68E+00	4760	Slug Test	BEI
	505	3.66E-01	1038	Slug Test	Hydrometrics
	507	6.40E-01	1810	Slug Test	BEI
	517	7.20E-01	2040	Slug Test	BEI
	518	1.49E-01	422	Slug Test	Hydrometrics

	Deep Wells	Hydraulic Conductivity cm/s	Hydraulic Conductivity ft/day	Type of Test	Source
MICHAUD FLATS	103	5.20E-03	14.7	Slug Test	BEI
	107	2.20E-02	62.4	Slug Test	BEI
	109	5.15E-03	14.6	Slug Test	BEI
	125	7.22E-02	205	Slug Test	Hydrometrics
	133	1.20E-01	340	Slug Test	BEI
	145	2.15E-01	609	Slug Test	BEI
	500	6.70E-02	190	Slug Test	BEI
BANNOCK RANGE	315	1.19E-02	33.7	Slug Test	BEI
PORTNEUF RIVER	311	8.60E-04	2.44	Slug Test	BEI
	317	9.90E-03	28.1	Slug Test	BEI
	319	1.00E-02	28.4	Slug Test	BEI
	321	1.50E-01	425	Slug Test	BEI
	322	2.80E-01	794.7	Pumping Test	BEI
	329	3.65E-01	1030	Slug Test	BEI
	330	5.64E-02	160	Slug Test	Hydrometrics
	504	7.10E-02	201	Slug Test	Hydrometrics
	506	2.30E-01	652	Slug Test	BEI
	512	5.80E-01	1640	Slug Test	BEI
	519	1.59E-02	45.0	Slug Test	Hydrometrics

	Production Wells	Transmissivity (ft^2/day)	Transmissivity (gpd/ft)	Type of Test	Source
MICHAUD FLATS	FMC-6	7370	55130	Pumping Test	BEI
	32ACD1	35100	262550	Pumping Test	USGS
	32DDC1	135700	1015000	Pumping Test	USGS
	33BAA1	21900	163810	Pumping Test	USGS
	33CCD1	41400	309670	Pumping Test	USGS
	34ADD1	40400	302190	Pumping Test	USGS
	34DCC1	36600	273770	Pumping Test	USGS
	35DDC1	164400	1229700	Pumping Test	USGS
	3ACD1	41200	308176	Pumping Test	USGS
	3BDC1	444000	3321100	Pumping Test	USGS
	4BBA1	38500	287980	Pumping Test	USGS
	5BDA1	36800	275260	Pumping Test	USGS
	8ADA1	27300	204200	Pumping Test	USGS
	9CAC1	199000	1488500	Pumping Test	USGS
	12BBC1	54700	409160	Pumping Test	USGS
PORTNEUF RIVER	SWP-7	227270	1700000	Pumping Test	Simplot

References: BEI = Bechtel Environmental, Inc., Preliminary Site Characterization Summary for the Eastern Michaud Flats site, January, 1994
PEI = PEI Associates, Inc., Evaluation of Waste Management for Phosphate Processing, April 1985
Hydrometrics = Hydrometrics, Inc., Hydraulic Conductivity Testing of Existing Well Sites at the Eastern Michaud Flats Site, Pocatello, Idaho, April 1994
USGS = United States Geological Survey, Water-Resources Investigations Report 84-4201, Hydrogeology of Eastern Michaud Flats, Fort Hall Indian Reservation, Idaho
Simplot = J.R. Simplot files
FMC = FMC files

Hydraulic conductivity at Well 318 not used in K-zone mapping due to potential precipitation reactions in formation related to mixing of low pH water with groundwater.
Transmissivity at Well 311 not used due to possible grout contamination in filter pack.



Note:
Hydrogeologic sections were constructed by projecting borings onto nearest plane. Point to point lines on this figure are illustrative only.

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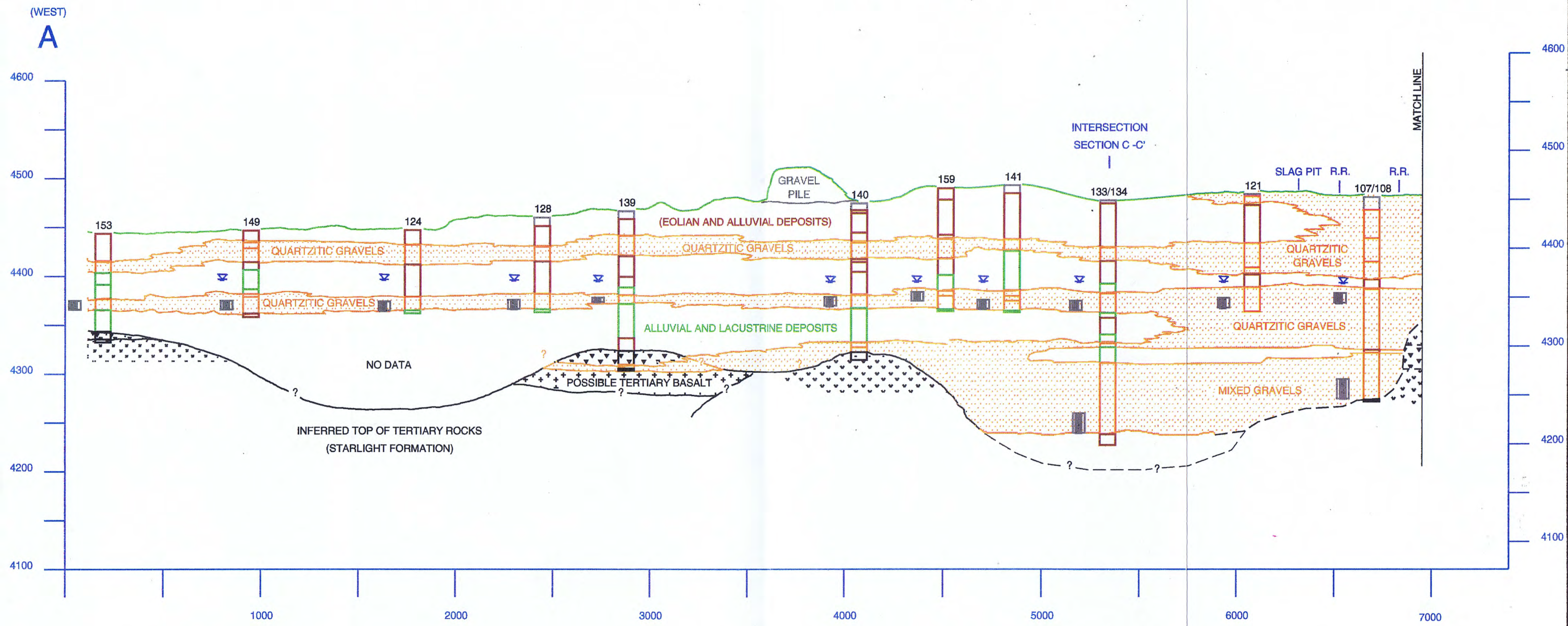
POCATELLO, IDAHO

Locations of Hydrogeologic Sections

Job Number	Drawing No.	Rev.
21372	FIGURE 3.1-5	

EMF emfxspv2 1/7/94



Legend:

Water level

Well screen

SAND
GRAVELLY SAND
SILTY SAND
CLAYEY SAND
SANDSTONE
GRAVEL
SAND AND GRAVEL
SILTY, SANDY GRAVEL
SILTY GRAVEL
CLAYEY GRAVEL

SILT
CLAYEY SILT
SANDY SILT
GRAVELLY SILT

CLAY
SILTY CLAY
SANDY CLAY
GRAVELLY CLAY

BASALT
RHYOLITE
TUFF

CALICHE
PEAT

ASPHALT
CONCRETE
FILL

NOTES:

1) Ground surface line is generalized
2) Vertical exaggeration = 5x
3) Cross-section is generalized. See boring logs in Appendix for further details.

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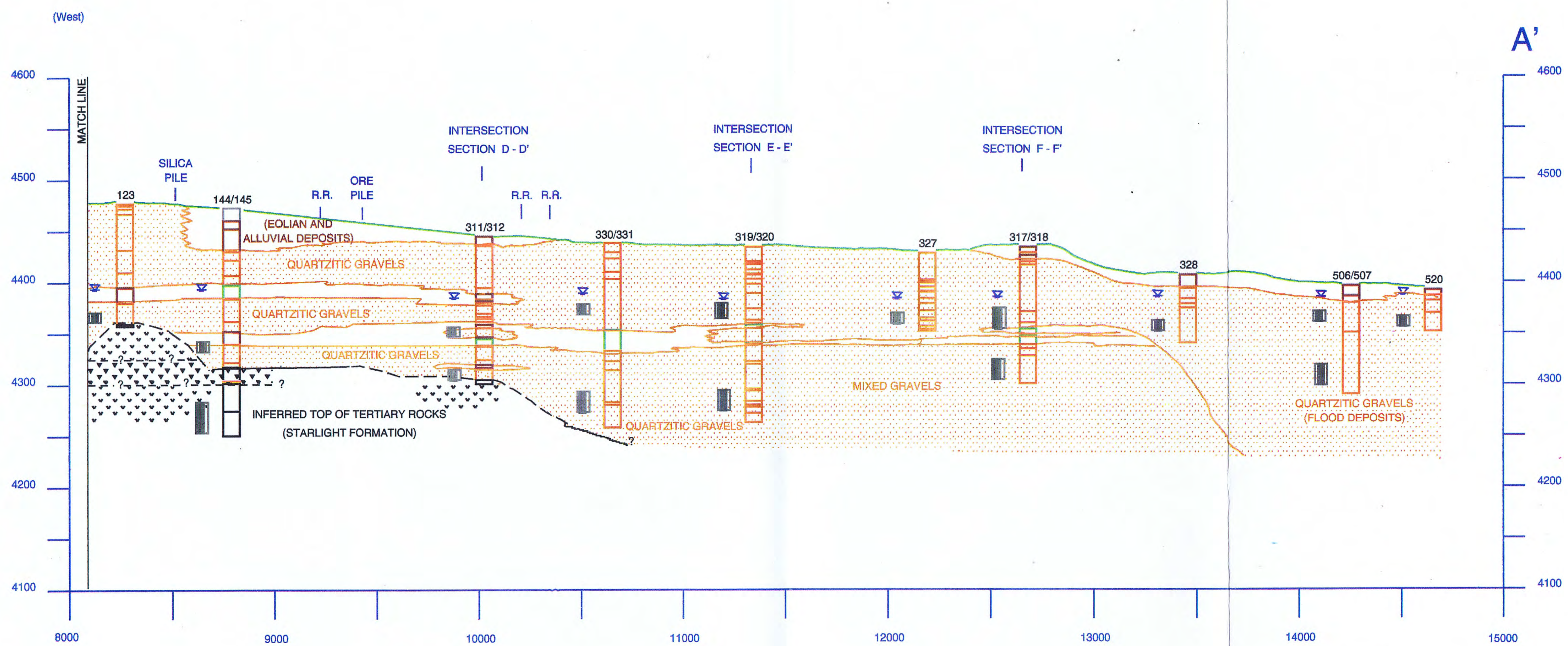
EASTERN MICHAUD FLATS POCATELLO, IDAHO		
Hydrogeologic Cross-Section A-A' sheet 1 of 2		
Job Number	Drawing No.	Rev.
21372	FIGURE 3.1-6A	

BMF emfxsob3.dgn 1/6



Legend:

- Water Level
- Well Screen

SAND
GRAVELLY SAND
SILTY SAND
CLAYEY SAND
SANDSTONE
GRAVEL
SAND AND GRAVEL
SILTY, SANDY GRAVEL
SILTY GRAVEL
CLAYEY GRAVEL

SILT
CLAYEY SILT
SANDY SILT
GRAVELLY SILT

CLAY
SILTY CLAY
SANDY CLAY
GRAVELLY CLAY

BASALT
RHYOLITE
TUFF

CALICHE
PEAT

ASPHALT
CONCRETE
FILL

NOTES:

1) Ground surface line is generalized
2) Vertical exaggeration = 5x
3) Cross-section is generalized. See boring logs in Appendix for further details.

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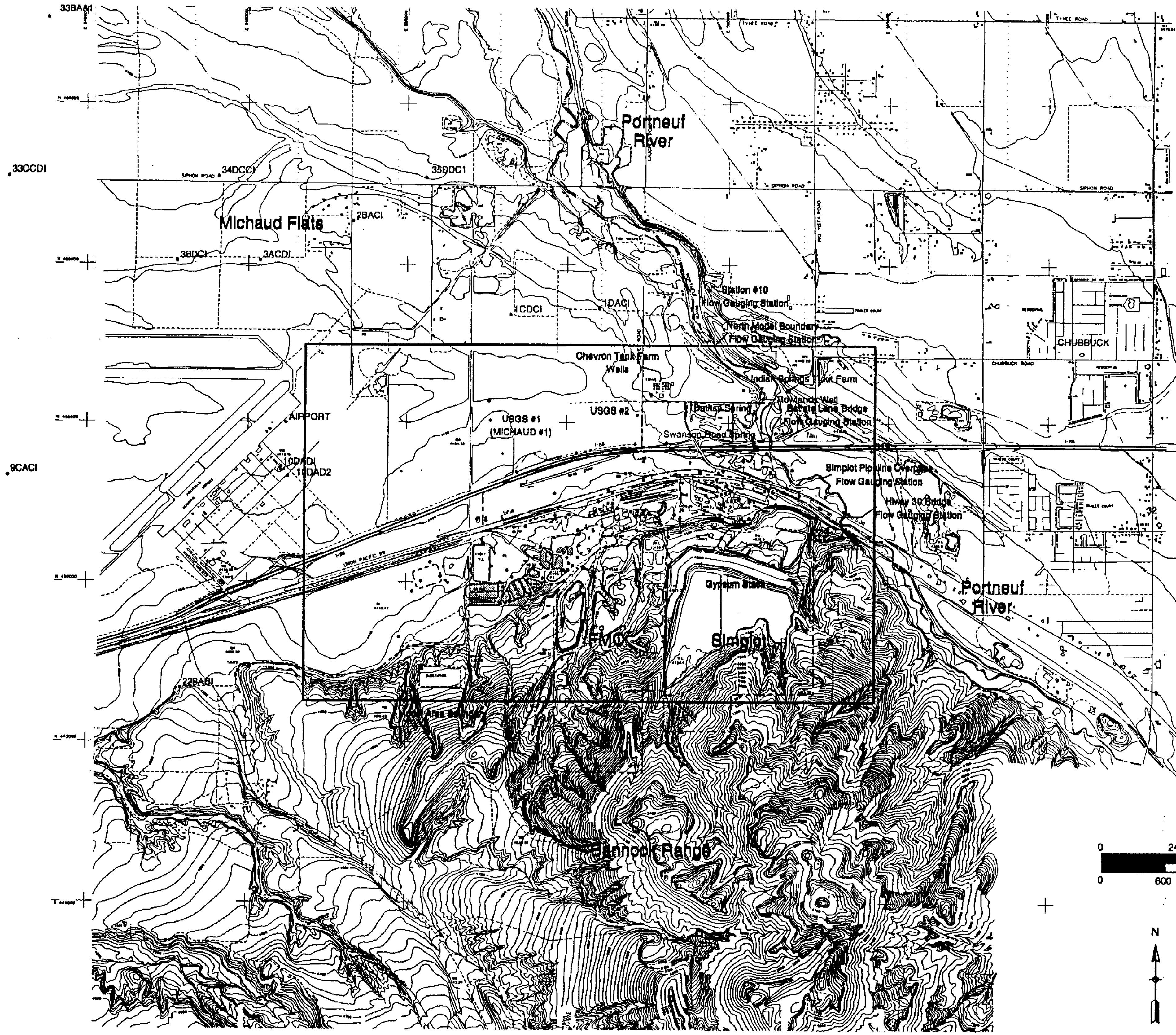
POCATELLO, IDAHO

Hydrogeologic Cross-Section A-A'
sheet 2 of 2

Job Number	Drawing No.	Rev.
21372	FIGURE 3.1-6B	

EMF emfxoobl.dgn 1/6/94



Legend

35DDC1 • Boring and Well Locations (See Figure 3.3-3 for Base Map & Well Designations Within Model Boundary)

Old Ponds (FMC)

Model Boundary

EMF Property Boundary

0 2400 4800 FEET

0 600 1200 METERS

N

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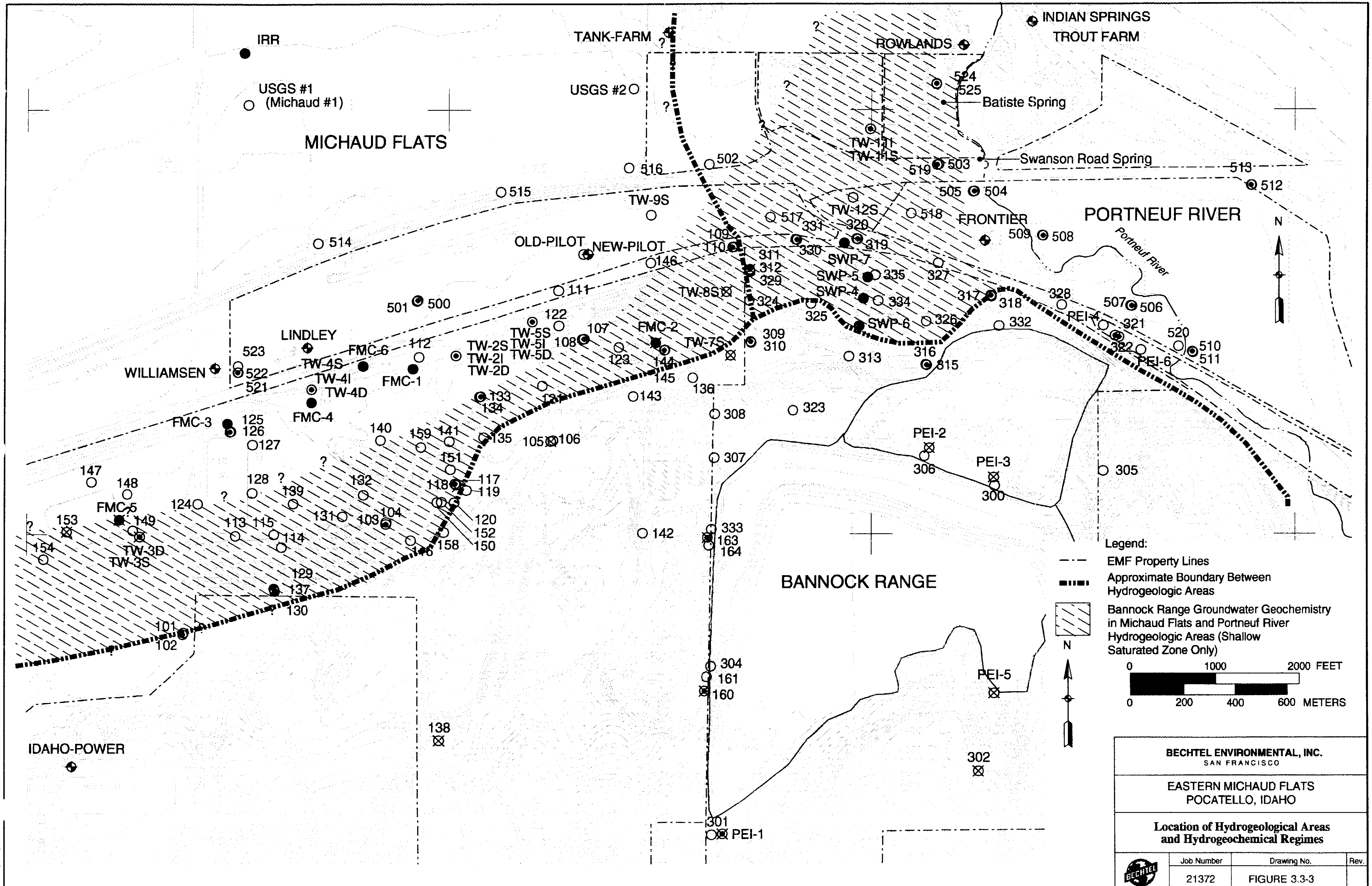
EMF Flow Model Study Area

Job Number	Drawing No.	Rev.
21372	FIGURE 3.3-2	



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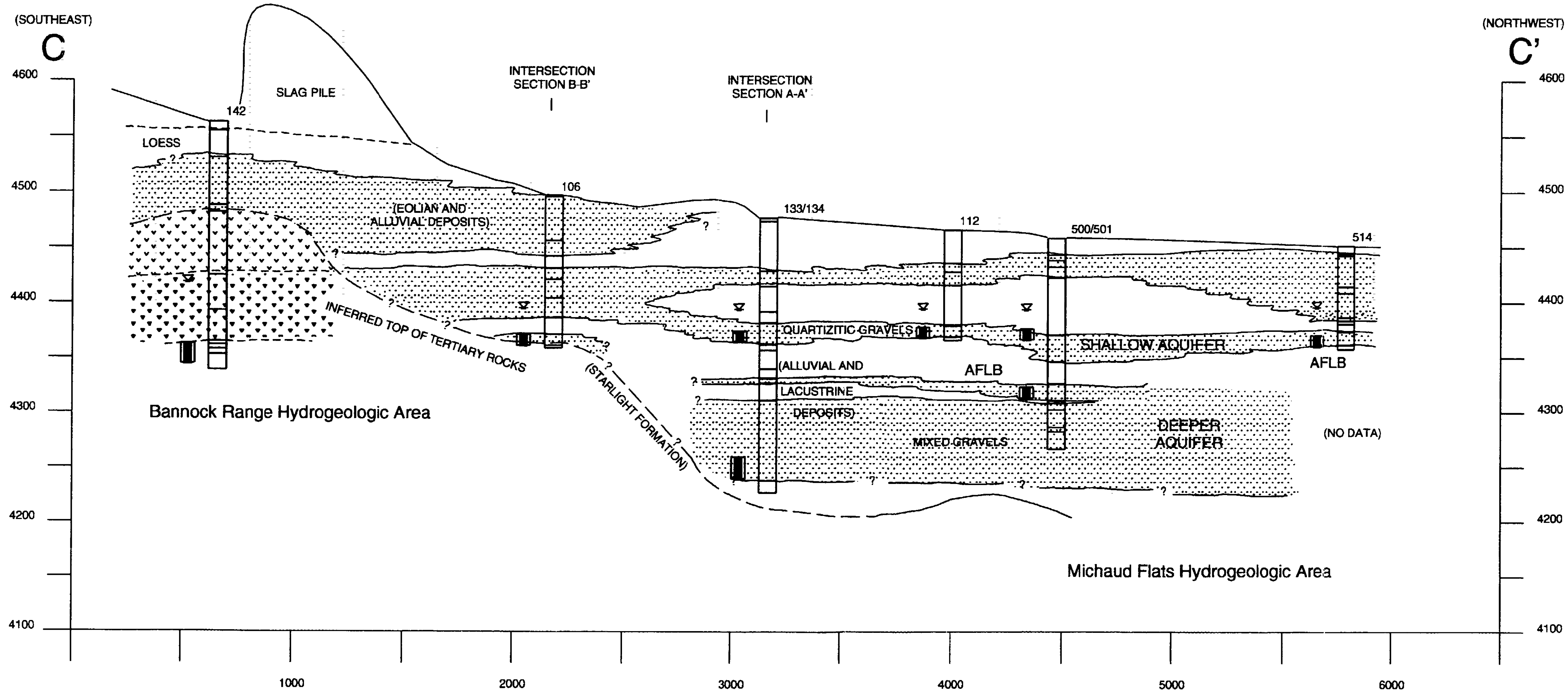
POCATELLO, IDAHO

Location of Hydrogeological Areas and Hydrogeochemical Regimes

Job Number	Drawing No.	Rev.
21372	FIGURE 3.3-3	

EMF emfhgch2.dgn 1/10/



Notes:

1) Ground surface line generalized.
2) Vertical exaggeration = 5x
3) Cross-section is generalized. See boring logs in Appendix for further details.
4) Cross-section lines are shown in Figure 3.1-5.
5) AFLB = American Falls Lake Beds

Legend:

Water level

Well screen

SAND
GRAVELLY SAND
SILTY SAND
CLAYEY SAND
SANDSTONE
GRAVEL
SAND AND GRAVEL
SILTY, SANDY GRAVEL
SILTY GRAVEL
CLAYEY GRAVEL

SILT
CLAYEY SILT
SANDY SILT
GRAVELLY SILT

CLAY
SILTY CLAY
SANDY CLAY
GRAVELLY CLAY

BASALT
RHYOLITE
TUFF

CALICHE
PEAT

ASPHALT
CONCRETE
FILL

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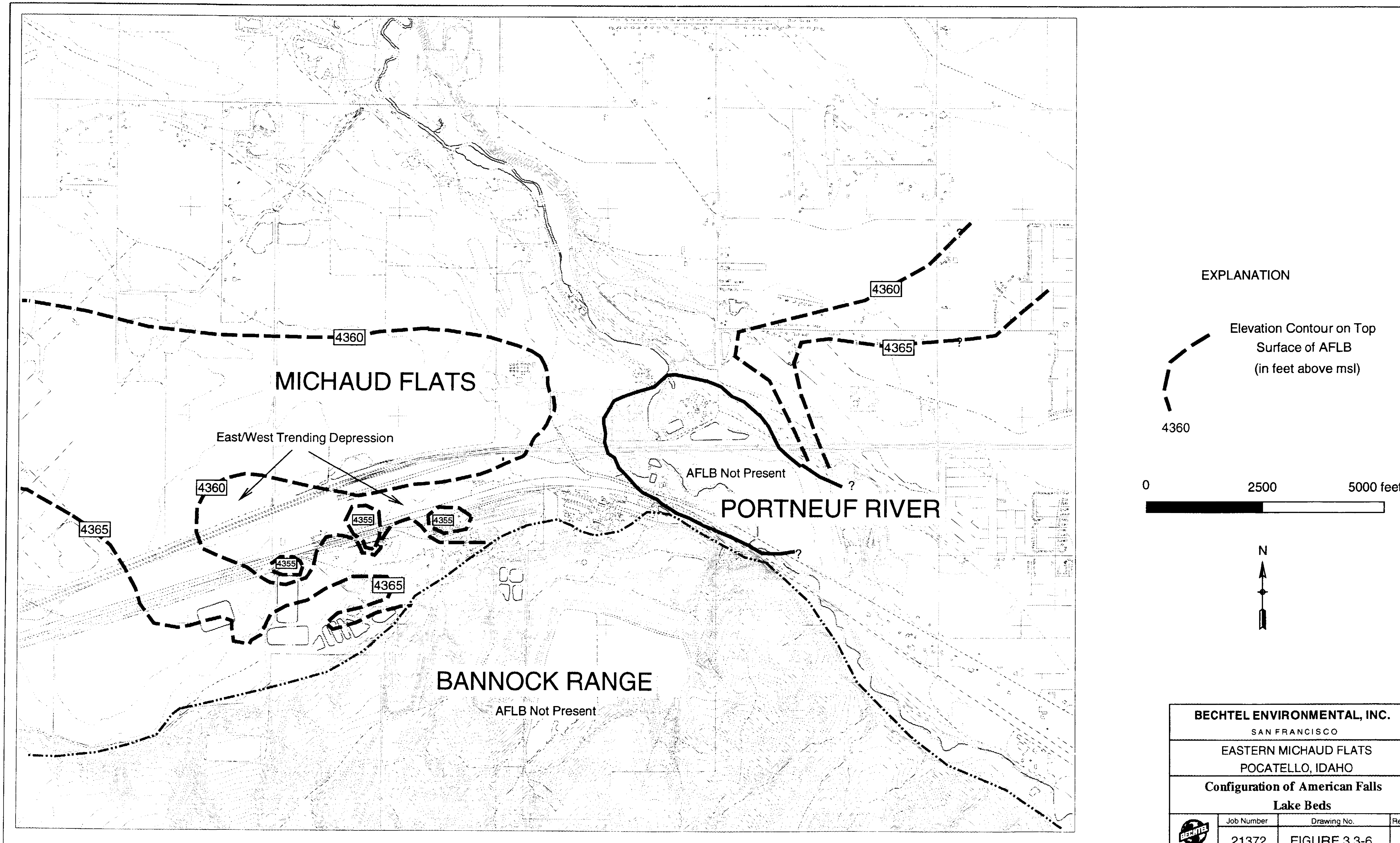
POCATELLO, IDAHO

Hydrogeologic Cross-Section C-C'

Job Number	Drawing No.	Rev.
21372	FIGURE 3.3-4	


MICHAUD FLATS
East/West Trending Depression
4360
4365
4355
AFLB Not Present
PORTNEUF RIVER
BANNOCK RANGE
AFLB Not Present
EXPLANATION
Elevation Contour on Top Surface of AFLB (in feet above msl)
4360
0
2500
5000 feet
N
BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO
EASTERN MICHAUD FLATS
POCATELLO, IDAHO
Configuration of American Falls Lake Beds
Job Number
21372
Drawing No.
FIGURE 3.3-6
Rev.

APPENDIX F

EPA and Agency Comments on the Hydrogeologic Study Work Plan (July 2013) and FMC Responses/Revisions

FMC Responses to EPA and SBT Comments, dated and received September 13, 2013, and IDEQ Comments, dated August 13 and received September 16, 2013, on the Extraction Zone Hydrogeologic Study Work Plan submitted July 15, 2013
October 31, 2013

EPA Comments Transmitted
September 13, 2013

Review comments, FMC OU Remedial Design, *Extraction Zone Hydrogeologic Study Work Plan*, MWH, July 2013

General Comments:

1. The above mentioned document has been reviewed and the methods for aquifer testing are appropriate being step test, constant rate pump test and the combined 72-hour constant rate test of the initial three extraction wells. These test results will provide the necessary site specific hydraulic parameters with the water level drawdown to aid in the development of the design for the hydraulic containment system (HCS).

   FMC Response: Comment noted as supportive of the study approach.

2. However, there must be continuous geologic logging and vertical water quality characterization profiling when installing the boreholes for the three extractions well and piezometers from the water table down to the American Fall lake bed (AFLB) or aquitard. This information will be needed when selecting the location for the screen interval of the extraction wells and piezometers.

   FMC Response: As stated in the Extraction Zone Hydrogeologic Study Work Plan (Work Plan), Appendix A, Section A.2.3, soil will be continuously logged from approximately 5 feet above the water table to the bottom of the boring during drilling of the extraction wells to identify specific soil horizons including the American Falls Lake Bed. This section will be revised to specify the same procedure will be followed during installation of the piezometers. The section will also be revised to clarify that the screen lengths will be based on observations made during drilling and after consulting with the MWH Hydrogeological Manager.

   With respect to vertical water quality characterization, Simplot's use of vertical groundwater quality monitoring during drilling appears to have been performed primarily to determine the screened intervals for multiple, nested wells which is not the case for the extraction wells and piezometers proposed in the Work Plan. However, vertical groundwater chemistry profiling during drilling of the extraction wells, similar to the method utilized by Simplot, will be added to the Work Plan. The revisions to Appendix A, Section A.2.3 of the Work Plan to address this comment are provided in underline/strikethrough format below:

A.2.3 Soil Sample Collection and Groundwater Chemistry Profiling Procedures

During drilling activities, soil samples for stratigraphic logging will be collected from the borehole prior to well installation. Soil samples will be collected either a split-spoon sampler or from soil cores (e.g., sonic drill cores). As necessary, a sample catcher will be placed at the end of the sampler so that unconsolidated soils are not lost as the sample device is retrieved from the borehole.

In the event that the HCS extraction wells and piezometers are installed using roto-sonic drilling methods, soil cores for stratigraphic logging will be collected continuously throughout the length of the borehole. However, if the extraction wells and piezometers installation is performed using other drill methods (i.e., air-rotary, etc.) soil samples will be collected using a split-spoon sampler at 5-foot centers above the water table, and then continuously from approximately 5 feet above the saturated zone to the bottom of the boring. Split-spoon, soil samples for piezometers installed shall ~~not~~ be collected following the same procedures as for the extraction wells. ~~until drilling depths have reached approximately 5 feet above the saturated zone; at which point samples for stratigraphic logging will be collected at five-foot centers to the bottom of the borehole.~~ Screened intervals will be selected based on stratigraphic interpretations and groundwater chemistry profiling during drilling activities and after consulting with the MWH Hydrogeological Manager.

Field analyses of groundwater samples for indicator constituents of site-affected groundwater will be performed during drilling of the extraction wells. The “real-time” analyses will be performed to supplement the stratigraphic interpretations for the selection of screen intervals.

Groundwater samples will be collected from the saturated zone during drilling. Since the roto-sonic, triple-wall air-percussion, or ARCH drilling methods will maintain an open borehole, groundwater encountered during drilling is most likely to originate in the zone between the end of the advance casing and the drill bit. A submersible pump or hydropunch groundwater sampling tip will be placed near the tip of the advance casing and the groundwater will be pumped to the surface for field analysis. Groundwater quality parameters (pH, temperature, and specific conductance) will be monitored during pumping until a representative sample can be obtained. Once representative conditions are observed, a sample of the discharge will be collected and analyzed in the field for the parameters listed in Table A.2.3-1. One sample will be collected and analyzed for approximately every 10 feet of drill depth within the saturated zone. The results will be used in conjunction with lithologic logging observations to select the interval for placement of the well screen.

Table A.2.3-1: Groundwater analyses conducted during drilling.

Analytical Parameter	Method
pH	Multi-probe field meter
Specific Conductance	Multi-probe field meter
Redox	Multi-probe field meter
Temperature	Multi-probe field meter
Nephelometric turbidity (NTU)	Turbidity meter
Phosphate	HACH portable Colorimeter

3. In order to improve the understanding of groundwater flow, a contour map of the top of the American Falls Lake Bed clay (AFLB) should be included in the work plan. In addition, the work plan should include a table that lists all monitoring and former production wells that have determined the depth of the top of the clay, the depth, and thickness of the AFLB clay if available. The contour map will enhance the conceptual site model for the site and the well information will be used during the selection of potential groundwater data for analysis and to select potential future monitoring well locations for sample collection and analysis.

   FMC Response: Figure 3.3-6 of the EMF RI Report (1996) that presents a contour map of the top of the AFLB was inadvertently omitted from the Work Plan. The intended appendix (now designated Appendix E) is attached to this response to comments. As shown on the figure, the top of the AFLB is expected to be encountered at an elevation between 4,350 and 4,365 feet above mean sea level (AMSL). The range of elevations for the top of the AFLB reported in the EMF RI has been confirmed and refined beneath the Simplot plant site. As shown on Figure 3-1 of Simplot's Supplemental Subsurface Investigation in the Phosphoric Acid Plant Area Report (July 2013), the top of the AFLB was encountered at an elevation between 4,350 and 4,375 feet AMSL (the AFLB was reportedly encountered at 4,381 AMSL in one boring).

   There is no existing table that lists all monitoring and former production wells that have determined the elevation of the top and thickness of the AFLB. As shown on EMF RI Report Figure 3.3-4 (included in Appendix E), the AFLB is about 35 to 15 feet thick based on the lithologic logs from well 133 (western ponds area) and well 500 (north of I-86). A review of deep boring logs from well 109 (next to well 110 in the northeast corner of the plant site), 140 (western ponds area) and well 109 (next to well 108 in the central plant area) shows a depth to the top and thickness of the AFLB consistent with EMF RI Figures 3.3-6 and 3.3-4 respectively. The additional information provided in this response will be added to paragraph 3 in Section 2.1.2 of the Work Plan as follows:

   > The AFLB form an aquitard that separates the shallow and deeper aquifers within the Michaud Flats area. These lacustrine clays and silts have very low permeability and are regionally extensive, extending from the Bannock Range area to the American Falls Reservoir, where they crop out along the reservoir embankment. <u>As shown on EMF RI Figure 3.3-6 (included in Appendix E), the top of the AFLB is expected to be encountered at an elevation between 4,350 and 4,365 feet above mean sea level</u>

(AMSL) in the extraction zone at the northeast property boundary of the FMC Plant site. The range of elevations for the top of the AFLB reported in the EMF RI has been confirmed and refined beneath the Simplot plant site. As shown on Figure 3-1 of Simplot's Supplemental Subsurface Investigation in the Phosphoric Acid Plant Area Report (July 2013), the top of the AFLB was encountered at an elevation between 4,350 and 4,375 feet AMSL (the AFLB was reportedly encountered at 4,381 AMSL in one boring).

As shown on EMF RI Report Figure 3.3-4 (included in Appendix E), the AFLB is about 35 to 15 feet thick based on the lithologic logs from well 133 (western ponds area) and well 500 (north of I-86). A review of deep boring logs from well 109 (next to well 110 in the northeast corner of the plant site), 140 (western ponds area) and well 109 (next to well 108 in the central plant area) shows a depth to the top and thickness of the AFLB consistent with EMF RI Figures 3.3-6 and 3.3-4 respectively.

The AFLB are not present along part of the Portneuf River in the area of Batiste Springs and Wells 524/525 south to Well 520 (see EMF RI Figure 3.3-6, in Appendix B). The Bonneville Flood may have scoured the AFLB, consistent with Trimble's (1976) map of boulder deposition patterns that indicate a main flood channel in this area. Elevation contours on the top of the AFLB suggest a slight dip to the north. Just to the south of I-86, there is an elongated, east-west depression in the AFLB surface, which may also be an erosional feature of the flood (see EMF RI Figure 3.3-6, in Appendix B).

Specific Comments:

1.0 Introduction,

1. page 1-1. The second paragraph describes the collection of groundwater samples from the extraction zones of wells EW-01-3 for laboratory analyses and a bulk water sample for a potential jar test for the evaluation of a water treatment system for the groundwater. No table could be found in this document which states the number of field samples, duplicates and QA samples. This table should be included in Section 4 or in the QAPP.

   FMC Response: The number and type of groundwater samples that will be collected are described in Section 3.5.2. A table could be added to this section; however, the text is clear that 2 discrete samples will be collected from each well during the six-hour step tests and 1 composite and bulk sample will be collected during the 72-hour combined pump test. Given the type of samples and the purpose of the sampling and analyses, to refine the expected average extracted groundwater quality and further evaluate the disposal method (i.e., disposal at the Pocatello POTW and/or on-site treatment) during design, field quality assurance samples were not deemed to be necessary. No revision to the Work Plan is warranted.

2. 1.3.2 Phase I HCS Pump Tests, page 1-4. The text states that the 24-hour constant rate pump test will only be performed on the western extraction well (EW-01). It is important to stress the aquifer at all three locations. Each of the wells (EW-02 and EW-03) must undergo the 24-hour constant rate pump test.

FMC Response: The measured drawdown during the proposed step-testing of the individual extraction wells will provide the relevant information on the hydraulic characteristics in the vicinity of each extraction well. Larger scale hydraulic characteristics and aquifer response will be derived from the combined three-well 72-hour testing. The additional 24-hour testing of each individual well is unnecessary at this time because it will provide little additional insight into the operation of the HCS given the context of the 72-hour testing of the entire system. In addition, as noted in EPA Specific Comment 12, the proposed 6-hour step tests at three extraction wells, 24-hour constant rate aquifer test at extraction well EW-01 and 72-hour hydraulic containment test (all three extraction wells) will produce about 1.5 million gallons of water that will be characterized and managed as described in SOP-4 (Investigation Derived Waste). Additional 24-hour pump tests at the other two extraction wells would add about another 300,000 gallons that would need to be managed during this study. No revision to the Work Plan is warranted.

<u>2.0 FMC OU Hydrogeology and Groundwater Modeling Summary</u>

3. Section 2.1.1, second paragraph. The text refers to EMF RI Report Figure 3.3-2 as being located in Appendix B of the plan. The figure could not be located in Appendix B and should be included.

   FMC Response: An appendix to contain the referenced EMF RI figures was inadvertently omitted from the Work Plan. The intended appendix (now designated Appendix E) is attached to this response to comments.

4. Section 2.1.2, third paragraph. The text refers twice to EMF RI Figure 3.3-6 as being located in Appendix B of the plan. The figure could not be located in Appendix B and should be included.

   FMC Response: An appendix to contain the referenced EMF RI figures was inadvertently omitted from the Work Plan. The intended appendix (now designated Appendix E) is attached to this response to comments.

5. 2.1.3 Aquifer Test Results, page 2-3. Include Table 3.3-1 Hydraulic Conductivities and Transmissivities of EMF Aquifer from the EMF RI with this document.

   FMC Response: Table 3.3-1 from the EMF RI has been added to the now designated Appendix E that is attached to this response to comments.

6. Second paragraph, the conversion from 0.1 cm/s to ft/day must be corrected in the text.

   FMC Response: The typographical error will be corrected (i.e., the value will be corrected to 28<u>3</u> ft/day).

<u>3.0 Hydrogeologic Study Design</u>

7. Section 3**.** Figure 1-3 presents the results of the flow path modeling which shows that the selected wells are likely to capture groundwater from the western plant area but would not capture groundwater from the eastern plant area. The two unnamed wells east of well EW-03 would apparently potentially capture groundwater from the eastern portion of the site, but are not included in this study. Groundwater monitoring results indicate that groundwater quality in wells 123, 145, and 136 is more contaminated than the average concentration of contaminants in wells 110, 146, and TW-9S presented in Table 3-2.

   While it is acknowledged that the source of contamination in wells 123, 136, and 145 may not have originated within the FMC OU, the situation should be acknowledged and discussed in the work plan. This discussion should include an analysis of why EW-01, EW-02, and EW-03 were selected for the study rather than the two locations further east. In addition, the text should describe how the results of the pump test will be used to evaluate the placement of extraction wells that will contain water from the eastern portion of the site as part of the remedy.

   FMC Response: The second paragraph in Section 3.1 (Preliminary Hydrogeologic Study Design) will be revised to include text describing the rationale for proposing to install the western three (3) extraction wells during this study and how the results will inform progressing with the groundwater remedial design (i.e., designing the system to capture groundwater flow from beneath the FMC plant site including the joint fenceline area) as follows:

   > Groundwater model results indicate that installation of five groundwater extraction wells at a spacing of approximately 350 to 500 feet will create hydraulic containment and prevent further migration of the contaminated groundwater plume beyond the FMC Site northern boundary. The approximate locations (final locations to be determined in the field) of the extraction wells and piezometers proposed for this study are shown on Figure 3-1. Extraction wells EW-01, -02 and 03 are located at the western three (3) locations of the preliminary groundwater extraction system design of five (5) extraction wells along the northeast FMC plant property. The eastern two (2) extraction wells from the preliminary design are shown on Figure 3-1 as modeled extraction wells.
   >
   > The western three (3) wells were selected for this study because, based on the groundwater model, these wells are predicted to capture the majority of the groundwater flow from beneath the FMC plant site and all the flow from the western ponds and central plant areas. Therefore, confirming the hydrogeology and aquifer characteristics at the western extraction wells is considered more critical to finalizing the overall groundwater extraction system than the eastern well locations that are modeled to intercept relatively low groundwater flow from the joint fenceline area. In addition, by including the “center” extraction well (based on the preliminary design), the updated groundwater model can be used to further refine the location(s) and designed extraction rate of well(s) toward the eastern plant property line to capture flow from the joint fenceline area. The design of the extraction wells and piezometers are described below.

8. 3.1.1 Extraction Wells, page 3-1. As mentioned in the general comments, it is important to have a good understanding of the site specific geology and the groundwater quality or the concentrations of the contaminants of concern (COCs). The Simplot OU of the EMF Superfund site used the roto-sonic drilling method and was able to get good recovery of the geology/lithology and was able to collect water quality samples using a field test kits for both phosphate and sulfate to make decisions on the placement of the screen interval and the length of the screen. This information would lead to a more effective extraction system by placing the screen interval through-out the known plume. Also, samples of the geological formation could be collected from the area selected as the screen interval to design a site specific filter pack around the screen. A roto-sonic drilling method is recommended by EPA based on the results from the Simplot design of their extraction system.

   FMC Response: Refer to the response to EPA General Comment #2. Note that FMC contacted Simplot regarding their experience with sonic drilling and they indicated that sonic was initially utilized to drill in the Bonneville flood gravel lithology in order to minimize lost drilling time or potential rejection when large boulders typical of the flood gravels were encountered. The Bonneville flood gravels are not present beneath the FMC plant site and percussion hammer drilling has successfully been used on previous soil boring and well installation programs at FMC. FMC is confident that sonic, air rotary casing hammer (ARCH) or percussion hammer drilling methods will work for the drilling and installation of wells and that the subsurface geology can be accurately characterized by any of the three drilling methods.

9. Figure 3-2. Make the following changes to this figure, after the total depth of 120 feet add (to AFLB). The text in section 3.1.1 must match what was placed on figure 3.2 the text states a minimum of five-foot above the top of the screen for the filter pack and figure has 2-feet. I agree with the text (5-feet). As mentioned above, a field decision will be made on the length of the screen interval and this figure should state an approximate length, like 15 to 30 feet.

   FMC Response: As suggested by the comment, Figure 3-2 will be revised as follows:

   - Filter pack has been changed from a minimum of 2 feet above well screen to a minimum of 5 feet above well screen;

   - Screened interval for both the extraction well and piezometer has been changed from 40 feet to 15 to 40 feet; and

   - Total Depth = 120 feet (approximate) has been changed to Total Depth = 120 feet (approximate of the top of the American Falls Lake Bed deposit).

   The revised Figure 3-2 is attached to this response to comments.

10. 3.1.2 Extraction Well Co-Installed Piezometers, page 3-2. The internal piezometers must have the same length of screen interval as the extraction well screen.

FMC Response: Section 3.1.2 (Extraction Well Co-Installed Piezometers) will be revised to clarify that the co-installed piezometers will have the same screened interval and screen lengths as the extraction wells as follows:

> Each six-inch diameter extraction well will have a one-inch diameter internal piezometer co-installed within the boring to allow the system operator to determine the water level within the well using a pressure transducer. The internal piezometers will have ~~approximately 40-foot long PVC~~ the same screen ~~of the same~~ length and slot size as the extraction well screen (refer to Figure 3-1).

11. 3.2 Groundwater Piezometers, page 3-2. An additional piezometer is needed down gradient of EW-02 which should be located closer then [sic] MW-146.

    FMC Response: While the downgradient piezometer would preferably be located closer to EW-02, the piezometer cannot be located closer due to the Union Pacific (UP) main line railroad tracks. Locating the piezometer on the south side of the UP tracks is too close to EW-02 to provide data that would add significantly to the piezometer located within EW-02 and the other piezometers to the south of the UP tracks. No revision of the Work Plan is warranted.

12. 3.3 Aquifer Testing Network and Procedures, page 3-3. What was the rationale used for the selection of the locations for EW-01, 02 and 03? Why not place EW-01 or the extraction wells closer to the higher concentrations of the COCs, MW-122 or MW-145?

    FMC Response: The EPA selected groundwater remedy specified in the IRODA is to "install an interim groundwater extraction/treatment system to contain contaminated groundwater, thereby prevent contaminated groundwater from migrating beyond the FMC OU and into the Simplot OU, and/or adjoining springs or the Porteneuf River." The selected remedy is based on SFS groundwater alternative 2 which was developed and refined during the development of the groundwater flow and transport model for the FMC OU. The groundwater model was developed over an approximately 1 year period (May 2009 through the July 2010 final groundwater model report) with significant review and input from EPA and opportunity for review and input from IDEQ and the Tribes. Appendix A of the Groundwater Model Report for the FMC Plant OU (Appendix E of the SFS Report, July 2010) includes the meeting minutes, presentation materials and follow-up materials from the six (6) meetings, including the July 2009 site visit, that were conducted to obtain review and input on the groundwater model. Multiple iterations of extraction well locations and rates were simulated to capture the shallow groundwater contaminant plume at the northeastern FMC plant site boundary during development of groundwater remedial alternative 2. The optimum configuration and preliminary design (as described in the IRODA) is for five (5) extraction wells located along the northeastern property line extracting a combined total of about 530 gallons per minute (gpm). The Work Plan was developed consistent with the preliminary groundwater remedial design documented in the IRODA, no revision to the Work Plan is warranted.

12. (cont.) Again all three wells (EW-01, 02 & 03) need to undergo a 24-hour constant rate aquifer test.

FMC Response: Refer to the response to EPA Specific Comment #2 above.

12. (cont.) The text in this section states that the extracted groundwater from phase I aquifer testing will be contained in storage tanks and characterized and cites SOP 4 (Investigation Derived Waste) as the SOP. Upon review of this SOP it looks as the purge water from the aquifer test may not be contained or tested but the rationale that may be used "*Over 20 years of analyses of groundwater from monitoring wells in the proximity of the planned wells /piezometers do not demonstrate any characteristics of a hazardous waste, and therefore would not be hazardous.*" The SOP continues to state that since it is not a hazardous waste it will be treated as a solid waste and can be disposed on site but it does not say where this water will be discharged. It is important not to discharge the purge water near the aquifer test site because it will comprise the results of this test. The location of the where the aquifer test purge water must be known. The approximate volume of water is + 1.2 million gallons. Also, the nearby monitoring wells, MW-123 and 145(based on second quarter 2009 data) shows concentration of arsenic at 205 µg/L and 483 µg/L. These concentrations are above the site standards of 10µg/L. It is not clear on how this purge water or IDW will be handled. More information is needed on how this IDW will be handled. I [sic] final determination of disposal will need to be made by EPA.

    FMC Response: As noted in the comment, Section 3.3 and SOP-4 state that well development and purge fluids will be containerized to await waste determination. SOP-4 states that the well development / purge fluids will be characterized through the use of existing information (previous test results, previous waste characterization, knowledge of the contaminants present, and other relevant records). As re-stated in the EPA comment, "*Over 20 years of analyses of groundwater from monitoring wells in the proximity of the planned wells /piezometers do not demonstrate any characteristics of a hazardous waste, and therefore would not be hazardous*" is an accurate statement and could be expanded to state that during the over 20 years of groundwater monitoring at the FMC OU, including sampling from approximately 125 monitoring wells at the FMC OU, over 4,500 samples and over 50,000 individual analytical results, no groundwater sample result has ever exceeded the threshold values for RCRA characteristic waste. Waste determination using process knowledge is consistent with 40 CFR Part 262.11.

    FMC agrees with the comment to the extend it implies that the purge water should not be managed in a manner that could allow the water to "short-circuit" through the annulus of nearby monitoring wells. As stated in Section 3.3 of the Work Plan, "If determined to be non-hazardous, the water will be utilized for dust-suppression activities on site." After containerization and characterization per SOP-4, FMC intends to load the water into water trucks for dust control on the site. For dust control, the approximately 1.5 million gallons of water that will be pumped over an approximately one week period during this study would represent a total of about 0.014 inches (or about 0.003 inches per day) of water spread over about a 340 acre area of the plant site (site-wide roadways and areas within RA-A). This minor amount of water spread over the site for dust control cannot be considered even a marginal threat to migrate to groundwater.

Needless to say, FMC does not have a manufacturing plant process to utilize the aquifer test water (unlike Simplot), does not have a sewer or NPDES discharge permit that would allow discharge of the purge water and containerization for off-site disposal would be prohibitively expensive (even at an unrealistically low unit cost of $1.00 per gallon for transportation and disposal). In the event EPA dictates water management / disposal other than use for dust control on-site, the schedule and scope of the study will need to be significantly reviewed and modified as appropriate. No revision to the Work Plan proposed pending further direction from EPA.

13. 3.4 Aquifer Testing Analysis and Model Update, page 3-3. The EPA does not see a need to make prediction of the long-term performance of the capture zone but must develop an evaluation method for determination of the capture zone for all of the extraction wells and to make sure that the contaminant plume is being captured. The EPA has a guidelines document, A *Systematic Approach for Evaluation of Capture Zones at Pump and Treat System*, (EPA 600/R-08/003, January 2008). This document uses a six step process for the evaluation of the extraction network for capture zones through a groundwater monitoring network. The EPA recommends a systematic approach for the evaluation of capture zones using multiple lines of evidence.

FMC Response: As stated in Section 1.2 of the Work Plan, the hydrogeologic study results will be used to develop the final design of the groundwater remedy hydraulic containment system (HCS) and will assist in selecting between the water management options. The refinement of the FMC OU groundwater model and additional groundwater remedial action simulations described in Section 3.4 of the Work Plan is consistent with developing the final design of the HCS. However, the text will be revised to clarify that the model refinement and simulations will be performed to refine the design of the HCS as follows:

> The revised numerical model will then be used to assess the potential long-term (100-year) performance (drawdown, hydraulic gradient, and flow net) of the initial three extraction wells. Results from these simulations will be used to ~~determine~~ predict if the three extraction wells are expected to meet the performance objectives of the HCS design. If the additional two (2) eastern extraction wells (or additional well[s])) are ~~deemed~~ predicted to be necessary, the model results will be used to assist in selecting the appropriate locations of any additional extraction wells predicted to meet the performance objectives of the HCS. Additional simulations may also be performed to assess and optimize the pumping distribution among the extraction wells to improve the design ~~performance~~ of the HCS.

As specified in the UAO, FMC is required to prepare a Final Groundwater Monitoring Plan as a component of the Remedial Action Work Plan (RAWP). The Final Groundwater Monitoring Plan will provide for, among other required elements, “an EPA Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems (EPA 600/R-08/003, 2008) will be used to evaluate the effectiveness of the Pump and Treat System. An evaluation of the groundwater monitoring network will be conducted to confirm that it is adequate to monitor the FMC OU.” The Hydrogeologic Study Work Plan was not developed to address that requirement of the UAO. Pursuant to the UAO, the RAWP will be submitted to EPA concurrently with the Pre-final Remedial Design.

14. 3.5.1 Water Level Measurements, page 3-4. Table 3-1 must include another column next to the column location identification number, being the screen interval (MSL) for each well location. Also, the column 1-2 hour for the collection of water level data is not needed and should be deleted. That information will be covered in the previous column and the column after.

    FMC Response: Table 3-1 will be revised to include elevations for the top and bottom of the screened interval for existing monitoring wells and the 1-2 hour piezometric surface elevation measurement column has been deleted as suggested by the comment.

15. 3.5.2 Groundwater Sample Collection, page 3-4. No information was provided on the number of water quality samples collected during these two aquifer test being the six hour step-test and the 72-hour pump test. Either table 3-2 or another table is needed that identifies the sample location, the parameters, number of samples, duplicates, MS/MSD, blanks etc. No such table could be found in section 4, QAPP. No mentioned is made on how this data will be validated for data use.

    FMC Response: As stated in the response to Specific Comment #1, the number and type of groundwater samples that will be collected are described in Section 3.5.2. A table could be added to this section; however, the text is clear that 2 discrete samples will be collected from each well during the six-hour step tests and 1 composite and bulk sample will be collected during the 72-hour combined pump test. Given the type of samples and the purpose of the sampling and analyses, to refine the expected average extracted groundwater quality and further evaluate the disposal method (i.e., disposal at the Pocatello POTW and/or on-site treatment) during design, field quality assurance samples were not deemed to be necessary.

    The laboratory analytical results for the extraction well groundwater samples will be validated consistent with the Data Verification and Validation Protocol for FMC's groundwater monitoring programs (Appendix C of the Interim CERCLA Groundwater Monitoring Plan, July 2010). A new paragraph will be added to Section 4.3.3 of the Work Plan as follows:

    > The laboratory analytical results for the groundwater samples from the extraction wells will be validated consistent with the Data Verification and Validation Protocol for FMC's groundwater monitoring programs (Appendix C of the Interim CERCLA Groundwater Monitoring Plan, July 2010). A Level III data verification will be performed on the sample results. Level III verification involves a review of all administrative documents, including field and laboratory chain-of-custody documents, sample preservation records, and sample preparation logs. For all precision and accuracy evaluations, laboratory summary information and forms will be evaluated for the individual laboratory methods.

15. (cont.) If a treatability study is going to be conducted was there a work plan for this treatability study?

FMC Response: As stated in the text, the bulk groundwater samples will collected and retained for potential third-party vendor bench-top testing (emphasis added). There is no specific plan for that testing and thus no work plan.

16. Table 3-2. This table has a column of the average concentration of constituent in groundwater and list wells 110, 146 and TW-9S. Why were these locations selected? These wells are either down-gradient or cross-gradient of the three extraction wells that we undergo testing. If the objective is to show the potential water quality that will be collected from these three extraction wells then up-gradient monitoring wells must be selected and only average the concentration which is within the capture zone of those wells. As an example from figure 1-3, the particle tracking shows EW-01 using TW-5S & 122 the average total phosphorus concentration would be 10 mg/L and arsenic would be 60µg/L.

    FMC Response: EPA previously made essentially the same comment on the SFS Report (March 2010) and FMC responded to the comment in its June 11, 2010 response to those comments. More to the point, Table 3-2 of the Work Plan includes the average concentrations of constituents in groundwater (wells 110, 146, and TW-9S), groundwater cleanup standards and Pocatello POTW pretreatment limits, which were taken from the final SFS Report, for completeness and to show the project-required analytical reporting limits (DQOs) are appropriate (i.e., lower than the relevant comparative values). The actual analytical results from the individual extraction well groundwater samples during the six-hour step tests and the composite groundwater sample that will be collected during the 72-hour combined pump test will be the best representation of the extracted groundwater quality. No revision to the Work Plan is warranted.

    For reference, the EPA comment on the SFS Report and FMC's June 11, 2010 response are provided below.

> **Excerpted from: FMC Responses to EPA, IDEQ and Shoshone Bannock Tribes Comments on the Draft SFS Report for the FMC Plant OU, March 2010**
>
> **EPA Comment (May 2010)**: 7.5.3 Groundwater Alternative 2A- Source and Institutional Controls, Groundwater Extraction for Hydraulic Control at the Plant Site Boundary and Direct Discharge to POTW, page 7-53
> 6) The third paragraph, picked three monitoring wells and averaged the water quality (MW-110, 146, and TW-9S) as what may be expected regarding the water quality concentrations that will be conveyed to the POTW. These monitoring wells may be outside the influence of the five extraction wells. MW-123, 145,189 should be used instead; these monitoring wells are within the influence of the five extraction wells.
>
> **FMC Response (June 2010):** As discussed during the March 30 and 31, 2010 meeting between FMC, EPA, IDEQ and the Tribes, that reviewed preliminary agency comments on the SFS Report, FMC does not agree that the wells suggested in this comment for characterizing the water that would be sent to the POTW are representative of water quality at the Groundwater Alternative 2 extraction wells. Those wells are too distant from the extraction wells under this alternative and do not account for attenuation of groundwater COCs between the suggested wells and the

FMC northern boundary extraction area. However, FMC did evaluate extracted groundwater concentrations with two different sets of wells located within or very close (well 111) to the alternative 2A and 2B northern boundary extraction area. As shown in the summary table below, the average concentrations for the 3 well sets evaluated are essentially the same. Considering that these estimated average concentrations were developed to evaluate the most appropriate treatment methodology to meet the preliminary treatment targets for the A and B water disposal options, FMC does not believe the SFS Report needs to be revised to present a different or alternative set of wells to support selection of disposal options and/or identification of appropriate treatment technologies.

Parameter	Average Wells 110, 146 and TW-9S	Average Wells 110, 111 and 146	Average Wells 110 and 146
pH (Field)	7.01	7.02	6.99
SC (UMHOS/CM)	1521.7	1412.0	1361.5
Redox (mV)	-100.0	-99.6	-100.0
Potassium	43.4	40.4	35.9
Sulfate	168.0	166.7	171.5
Chloride	136.3	130.6	110.9
Fluoride	0.30	0.31	0.41
Ammonia	0.17	0.15	0.15
Nitrate	6.63	6.30	4.97
Orthophosphate/ Total Phosphorus	2.54	2.79	2.21
Arsenic	0.03	0.03	0.04
Flouride	0.34	0.36	0.47
Selenium	0.012	0.012	0.016

17. QAPP and FSP, page 4-1. A signature page is needed in the QAPP.

FMC Response: While FMC acknowledges that EPA's guidance suggests that QAPPs include a signature page, the relevant approval (i.e., signature) is the EPA RPM's approval of the Work Plan which presumably will be in the form of an EPA letter. A signature page does not appear to add any value to the QAPP contained in the Work Plan. No revision of the Work Plan is warranted.

18. 4.3 Data Quality Objectives, page 4-3. The data quality objectives should be stated in the text of this section and from the Table 4-1 only one data quality objective was stated, "Verify Model Predictions and determine the alignment and layout for the final design of the full-scale HCS to capture contaminated groundwater before it migrates beyond the FMC Plant site". The EPA believes there are three data quality objectives:

- To installation five extraction wells and associated piezometers which will contain the groundwater that has impacted the shallow aquifer.
- To conduct aquifer testing to obtain site specific hydraulic parameters to design a full-scale HCS
- To collect groundwater samples from the new installed extraction wells to determine the direction of water treatment either option A (discharge and treatment at the City of Pocatello POTW) or option B (on-site treatment followed by infiltration/evaporation).

It is recommended that EPA and FMC discuss the data quality objectives for this hydrogeologic study work plan. Once the agreed upon DQOs have been set then table 4-1 could be finalized.

FMC Response: FMC agrees that the introduction to Section 4.3 and Sections 4.3.1 could be expanded to include the observations (e.g., lithologic logging) and Section 4.3.3 needs to be revised to include the groundwater profiling (per response to EPA General Comment 2) that will be conducted during installation of the extraction wells. However, the first bullet in this comment does not accurately reflect an objective of the proposed extraction zone hydrogeologic study and appears to paraphrase the IRODA selected groundwater remedy that states "Install an interim groundwater extraction/treatment system to contain contaminated groundwater, thereby prevent contaminated groundwater from migrating beyond the FMC OU and into the Simplot OU and/or adjoining springs or the Portneuf River." As stated in the Work Plan, the proposed extraction wells and piezometers and aquifer testing will provide needed inputs to refine the groundwater extraction system remedial design. A "problem statement" to the effect that "there are no existing extraction wells in the identified groundwater extraction zone to implement the IRODA identified groundwater remedy for the FMC OU" that leads to a "decision" to install extraction wells / piezometers seems unnecessary and does not add value to the Work Plan. Similarly, a "problem statement" to the effect that "there is no extraction zone-specific hydrogeologic or aquifer characterization data" that leads to a "decision" to install extraction wells / piezometers in order to perform aquifer (pump) testing seems unnecessary and does not add value to the Work Plan.

The proposed revisions to the introduction to Section 4.3 and Sections 4.3.1 are provided below. If acceptable, conforming revisions will be made to Table 4-1.

4.3 DATA QUALITY OBJECTIVES

During execution of the Hydrogeologic Study there are three types of data to be collected:

- Qualitative / semi-quantitative observations associated with drilling the boreholes (e.g., lithologic logging), determination of the well screen interval and screen slot size, and development of the extraction wells and piezometers;

- Physical measurements (e.g., groundwater elevations) associated with drilling the boreholes (e.g., depth of lithologic samples), construction of the extraction wells and piezometers (e.g., setting bottom of casing), and aquifer pumping tests; and,

- Physical and chemical analyses of groundwater samples collected during drilling the boreholes for the extraction wells, during development of the extraction wells and piezometers, and during the aquifer testing from the extraction wells.

The Data Collection Quality Objectives for the Hydrogeological Study are presented in Table 4-1.

4.3.1 Extraction Well and Piezometer Installation

There is no "problem statement" associated with the installation of the extraction wells and piezometers during the execution of this Plan. Thus, no specific, numeric data quality objectives (DQOs) have been established. However, there will be numerous observation and measurements performed during drilling of the boreholes for the extraction wells that will be utilized to finalize well construction / completion details as summarized below:

Observation / Measurement during Drilling	**Extraction Well Construction Element**
Static water level in borehole	Top of screen will extend approximately 5 feet above static water level
Lithologic logging in saturated zone: soil types	Screened casing slot size
Groundwater chemistry profiling	Screen length and bottom of hole / well if SC < 500 umhos/cm and phosphate field analysis < 0.1 mg/l before encountering top of the AFLB
Lithologic logging: top of AFLB	Screen length and bottom of hole / well if SC > 500 umhos/cm and phosphate field analysis > 0.1 mg/l in sample at or above the top of the AFLB

As specified in Section A.2.3 of the Extraction Well and Piezometer Installation Field Procedures detailed in Appendix A, the screened interval for each extraction well will be selected based on stratigraphic interpretations and groundwater chemistry profiling during drilling activities and after consulting with the MWH Hydrogeological Manager. The use of qualified field personnel (geologists/hydrogeologists), adherence to the Extraction Well and Piezometer Installation Field Procedures detailed in Appendix A, and field documentation will assure the wells/piezometers will be installed properly and will meet the requirements for this hydrogeologic study and completing the design and ultimately the full-scale implementation of the HCS.

4.3.3 Groundwater Samples - Field and Laboratory Analyses

Field analyses will be performed on groundwater samples collected during drilling the boreholes for the extraction wells, during development of the extraction wells and piezometers, and during the aquifer testing from the extraction wells.

The groundwater field parameters will be measured utilizing calibrated field meters with the calibration frequency and accuracy specified on Table 3-2. Note that during drilling the extraction wells the groundwater chemistry profiling samples will be field analyzed for the parameters listed on Table A.2.3-1. The field meters for those parameters will meet the calibration frequency and accuracy specified on Table 3-2 with the exception of phosphate. Phosphate will be field-analyzed using a Hach portable colorimetric phosphate test kit (Model PO-23 or comparable). The Model PO-23 has two (2) measurement concentration ranges of 0.1 to 5 mg/l and 1 to 50 mg/l which should be adequate for the range of expected groundwater phosphate concentrations at the extraction well locations. Hach does not specify a calibration method / frequency or precision/accuracy information for their portable phosphate test kits.

In addition to the field analyses, groundwater samples will be collected from the extraction wells during the aquifer (pump) testing for laboratory analyses. The groundwater samples from the extraction wells will be analyzed at a NELAP-accredited analytical laboratory for the parameters specified on Table 3-2. The acceptable level of uncertainty is included in Table 3-2 as accuracy and precision goals. Samples will be collected and handled as described in Section 4.4.2 below. The specified reporting limits are below the lower of the groundwater cleanup standard or Pocatello POTW Pretreatment Limit to assure the data are useable.

19. 4.3.1 Extraction Well and Piezometer Installation, page 4-2. Problem statements and decisions must be identified for each DQO for sections 4.3.1-4.3.3

    FMC Response: Refer to the response to EPA Specific Comment 18.

20. 4.4 Sampling /Measurement Procedures. 4.4.1 Extraction Well and Piezometer Installation Procedures, page 4-3 and Appendix A, a.2.6

    The development of the 2" diameter piezometer should meet the same criteria of the extraction wells.

    FMC Response: The piezometers will be used strictly as observation points for ground water elevations and therefore do not need to be developed to the same extent as the extraction wells. However, as stated in Section A.2.6 of Appendix A (Well and Piezometer Development Procedures), the extraction wells and piezometers will be developed using a combination of a surge block and bailer and either a portable centrifugal pump, a submersible pump, or airlift pump. During extraction well and piezometer development, water quality parameters such as pH, specific conductivity, temperature, and turbidity will be monitored. These parameters will be measured with a portable water-quality meter. The parameters will be measured at the beginning of well development and after the evacuation of each borehole volume. A minimum of six rounds of water quality parameter measurements will be made; and well development will continue until the criteria set forth in Section A.2.6 are met. Specific to the piezometers, development will continue until the purged water is reasonably free of sediments (as determined by the MWH field representative). No revision to the Work Plan is warranted.

21. Appendix A, a.5. X and Y coordinates must be reported out in the state of Idaho state plane coordinates northing and eastings.

    FMC Response: Section A.5 references SOP-3 (Location and Topographic Survey) for surveying the extraction well and piezometer locations. As specified in SOP-3, all measurements will be referenced to the State Plane Coordinate System, North American Datum 1983 and North American Vertical Datum 1988. No revision of the Work Plan is warranted.

Shoshone-Bannock Tribes Comments, Email dated September 5, 2013 and Transmitted to FMC by EPA Email on September 13, 2013

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General comment:
 The Shoshone-Bannock Tribes would like to evaluate the groundwater model
report referenced throughout this document specifically, the parameters
selected for groundwater flow and contaminant transport models, assess the
reasonableness of predicted parameters, gain a better understanding of
sorption coefficients, dispersivity and porosity parameters.
```

FMC Response: As summarized in the response to EPA Specific Comment 12, the groundwater model was developed over an approximately 1 year period (May 2009 through the July 2010 final groundwater model report) with significant review and input from EPA and opportunity for review and input from IDEQ and the Tribes. Appendix A of the Groundwater Model Report for the FMC Plant OU (Appendix E of the SFS Report, July 2010) includes the meeting minutes, presentation materials and follow-up materials from the six (6) meetings, including the July 2009 site visit, that were conducted to obtain review and input on the groundwater model. The Tribes had full opportunity to review and provide input into the development of the groundwater flow and transport model and modeled groundwater remedial action simulations during the development of those models and Groundwater Model Report for the FMC Plant Operable Unit. No revision to the Work Plan warranted.

```
During the Step Drawdown, all production wells at Simplot should have their
pumping rates measured.  All irrigation wells within a determined radius
should be inventoried and identified for pumping rates.
```

FMC Response: The EMF RI Report and the Groundwater Current Conditions Report for the FMC Plant Operable Unit, June 2009 - Final (GWCCR) provide tabulated lists of surrounding production wells. More importantly, as documented in EMF RI Report, GWCCR and FMC's annual RCRA, CERCLA and Calciner Pond Groundwater Monitoring Reports (most recent annual reports for calendar year 2012), production patterns at Simplot or surrounding agricultural or other production wells have no observable influence on the groundwater potentiometric surface or inferred flow direction at the FMC OU. In addition, during FMC plant operation and utilization of production wells at the FMC OU, that pumping had no observable influence on the groundwater potentiometric surface or flow direction in areas surrounding the FMC OU. No revision to the Work Plan is warranted.

```
Section 2.1.1
 second bullet:  migration of site related constituents from shallow
groundwater to the deeper zone is inhibited by upward vertical hydraulic
gradients of confining strata throughout large portions of the EMF study
area.
 Add: however, site related COCs have been measured in wells in the deep
aquifer.  This groundwater discharges to the Portneuf River along both the
east and west side of the river and regionally.
```

FMC Response: The comment apparently is referring to bullet 2 in Section 2.1.4 of the Work Plan (no such statement appears in Section 2.1.1). The bulleted summary in in Section 2.1.4 of the Work Plan is accurate and was taken from the EPA-approved GWCCR. No revision to the Work Plan is warranted.

```
Third bullet:  remove limited to the area south of I-86 from this paragraph.
Water from the EMF area discharges to the Portneuf River which flows north of
I-86.
```

FMC Response: The comment apparently is referring to bullet 3 in Section 2.1.4 of the Work Plan (no such statement appears in Section 2.1.1). The bulleted summary in Section 2.1.4 of the Work Plan is accurate and was taken from the EPA-approved GWCCR. No revision to the Work Plan is warranted.

```
SOP 4-  All purged water must be tested for total metals  and meet the
Shoshone-Bannock Tribes soil cleanup standards and other appropriate
requirements prior to discharge on the ground.
```

FMC Response: Standard Operating Procedure (SOP 4) – Investigation-Derived Waste (IDW) Management was taken directly from the EPA-approved SOP No. 7 included in the Supplemental Remedial Investigation Work Plan (May 2007), and modified as appropriate for the Remedial Design field studies. The SOP is consistent with EPA regulations and guidance. No revision to the Work Plan is warranted.

FMC has consistently made its position clear in this CERCLA process that Tribal regulations do not and cannot constitute ARARs. As stated in the IRODA, EPA has not made a determination whether the Tribes' Soil Cleanup Standards for Contaminated Properties (SCS) are ARARs. No change to the Work Plan is warranted.

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Table 3-2 - The Tribes request total metals and radionuclides be analyzed
for. The Tribes request this information prior to discharge of any water
within the FMC OU.  Pumping at a low flow may be more representative of
actual groundwater conditions, at least for the initial first 10 minutes
.prior to sampling.
```

FMC Response: The laboratory analytical methods specified for the metals listed on Table 3-2 of the Work Plan are for total metals. No field or laboratory filtration of the groundwater samples for dissolved constituent analyses is proposed. As summarized in Section 8.1 of the EPA-approved GWCCR:

> Supplemental sampling events for expanded metals, organic compound and radionuclide analytical parameters have provided further evidence supporting the findings of the EMF RI that the following constituents are not FMC-related contaminants in groundwater:
>
> - Metals: aluminum, antimony, beryllium, cadmium, copper, lead, molybdenum, mercury, silver, thallium and zinc;
> - Organic Compounds; and
> - Radionuclides.

The existing groundwater sampling and analytical data demonstrates there is no justification to add any additional metals or radionuclides to the groundwater analyses for the samples collected during the extraction zone hydrogeologic study. No revision to the Work Plan is warranted.

`We may have additional comments based on the referenced modeling document.`

FMC Response: Comment noted; however, as stated in the response to the first Tribes' comment, the Tribes had full participation and opportunity to comment during development of the groundwater model and simulations presented in the EPA-approved Groundwater Model Report for the FMC Plant Operable Unit. No revision to the Work Plan is warranted.

Idaho Department of Environmental Quality Comments August 13, 2013

FMC OU Remedial Design Extraction Zone Hydrogeologic Study Work Plan July 2013

IDEQ Comments Received by FMC on September 16, 2013

General Comments

1. New well construction must meet standards set in IDAPA 37.03.09.

   FMC Response: The construction and decommissioning of wells associated with the remedial action will comply with the Idaho Department of Water Resources' (IDWR) Well Construction Standards Rules, IDAPA 37.03.09. As-built diagrams and driller reports will be provided to IDWR following completion of each well. However, the wells (and piezometers) installed pursuant to the CERCLA remedial action will not be permitted with IDWR pursuant to the CERCLA section 121(e)(1) permit exemption for removal or remedial action conducted entirely on-site.

2. Extraction wells should be designed to be as efficient as possible without producing large quantities of silt. This may require the collection of borehole cuttings from the targeted aquifer, conducting particle size analyses on the cutting samples, and then designing a well based on particle size distribution. If particle size analysis has been conducted during prior investigations that support the current selected well screen slot size (10 slot), those data should be presented in the work plan.

   FMC Response: The extraction wells have been designed to be efficient while also minimizing potential silt (or TSS) production. As described in the response to EPA General Comment 2, the soil will be continuously logged from approximately 5 feet above the water table to the bottom of the boring during drilling of the extraction wells to identify specific soil horizons including the American Falls Lake Bed. The currently identified extraction well screen slot size (0.010-inch) is potentially conservative (smaller than necessary) given that virtually all of the existing monitoring wells at the FMC OU have 0.020-inch slotted screen casing and only a few of the over 100 wells produce water with turbidity greater than 5 NTU as measured during purging. In addition to the revisions indicated in the response to EPA General Comment 2, Appendix A, Section A.2.3 of the Work Plan will be revised to clarify that the screen lengths and screen slot size will be based on observations made during drilling and after consulting with the MWH Hydrogeological Manager.

Specific Comments

1. **Page 1-4, section 1.3.2, line 5;**
   Delete the second '-hour'.

   FMC Response: The typographical error will be corrected.

2. **Page 2-2, section 2.1.2, paragraph 1, lines 5 and 6;**

   While the statement concerning the delineation of hydrostratigraphic units in the Bannock Range is technically correct it leads the reader to conclude sufficient effort was exerted during the RI to arrive at the conclusion presented here. DEQ does not agree sufficient evidence was provided to support the conclusion and finds the statement misleading. Please rewrite to present as a theory and not a fact, or provide the reader with information concerning the nature and extent of the Bannock Range hydrogeologic investigation.

   FMC Response: The text referenced in the comment will be revised to state:

   > Within the Bannock Range area there were no continuous hydrostratigraphic units delineated during the RI. Starlight Formation volcanic flows and interflow units ~~are~~ <u>were</u> not correlative, and the ~~overall~~ distribution of rock types and saturated materials <u>encountered in the RI borings</u> is best described as highly heterogeneous.

3. **Page 2-3, section 2.1.3, paragraph 2, line 2:**

   Replace '(28 ft/day)' with "(283 ft/day)".

   FMC Response: As stated in the response to EPA Specific Comment 6, the typographical error will be corrected (i.e., the value will be corrected to 28<u>3</u> ft/day).

4. **Page 2-3, section 2.1.3, paragraph 3, line 1:**

   Replace 'Measured' with "Estimated".

   FMC Response: The text will be revised as suggested in the comment.

5. **Page 2-4, section 2.1.3, paragraph 1, line 1;**

   The first sentence is incomplete, please correct.

   FMC Response: "Groundwater Elevations, Flow Patterns, and Vertical Gradients" was intended to be a subheading not a sentence. The Work Plan will be revised to format as a subheading and subsequent subheadings will be renumbered and the table of contents revised.

6. **Figure 3-2;**

   Change filter pack minimum height requirement to correlate with Section A.3.2.2 (page A-5 top of page).

   FMC Response: As stated in EPA Specific Comment 9, the filter pack has been changed from a minimum of 2 feet above well screen to a minimum of 5 feet above well screen. This change will be made consistently through the Work Plan and Appendix A.

7. **Page 4-2, section 4.3.1 and 4.3.2;**

   See General Comments 1 and 2. Poor well construction and data collection during the aquifer pump tests may result in over or under estimating aquifer parameters and the effectiveness of the

HCS as a result. DQOs should be set in place to ensure extraction wells are constructed properly and the best possible data is collected during the pump tests.

FMC Response: Refer to the response to EPA Specific Comment 18.

8. **Page 4-4, section 4.4.3, bullet 2;**
   Please include an explanation of how the variable pumping rates between wells will be accounted for in the composite sample.

   FMC Response: Section 4.4.3.2 (Sample Collection) provides a description and example for the composite sampling procedure:

   > "The composite sample will initially be collected in an approximately 5-gallon pre-cleaned container. An aliquot from each extraction well will be collected at the time intervals specified above and on Table 4-1. The volume of the aliquot from each well will be in proportion to the pump rates set for each well during the multi-extraction well containment pump test. For example, if well EW-1 is pumping at 120 gpm, well EW-2 at 100 gpm and EW-3 at 80 gpm, then the aliquot volume from EW-1 and EW-3 will be 20 percent greater and lower, respectively than the aliquot from well EW-2. As nine (9) total aliquots will be collected in a 5-gallon container, the "base" aliquot volume will be about 0.5 gallons."

   No revision to the Work Plan is warranted.

9. **Table 4-1, row 1, column 2 (HCS Model Predicted Capture Zone Determination);**
   Replace 'before if migrates' with "before it migrates".

   FMC Response: The typographical error will be corrected.

10. **Page 5-1, section 5.3 paragraph 1 line 1;**
    Replace 'gamma cap performance evaluation' with "extraction zone hydrogeologic study".

    FMC Response: The typographical/context error will be corrected.

11. **Page A-1, section A.2.3, paragraph 1, line 2;**
    Insert "using" between 'collected' and 'either'.

    FMC Response: The typographical error will be corrected.

12. **Page A-4, section A.3.2.1;**
    Please state how the final borehole depth will be determined, and the determining factors that will be used for selecting the length of the well screen. If the extraction wells are to be designed to extend over the entire aquifer thickness or some other length, please clearly state and provide justification.

    FMC Response: Refer to the response to EPA General Comment 2 and EPA Specific Comment 9.

13. Page A-4, section A.3.2.2, paragraph 1, line 4;

Refer to Figure 3-2 instead of Figure 3-1.

FMC Response: The reference will be corrected.

14. Page A-7, section A.4.2.3, paragraph 2, line 7;

Refers to Figure A-3, Figure A-3 could not be located, please correct accordingly.

FMC Response: A figure showing a typical above-ground completion for the piezometers was inadvertently omitted from Appendix A. Figure A-1 will be included that shows a typical above-ground completion will be included and is attached to this response to comments. In addition, as the piezometers will all be completed above-grade, the text describing flush mounted completions will be deleted from Section A.4.2.3 in Appendix A.

15. Page B-6, section B.3, 5th bullet, line 5,

The replacement of 'superposition of drawdown' with "well interference effects" is recommended.

FMC Response: The text will be revised as suggested in the comment.

16. Table B-3, row 1 (Extraction Wells), column 2 (Step-Drawdown and Constant Rate…);

Revise to maintain consistency with Appendix A.

FMC Response: The text that summarizes the extraction well construction (approximate depth and screen slot size and sand pack gradation) in Table B-3for Extraction Wells under Step-Drawdown and Constant Rate Extraction Well Test will be revised consistent with the response to EPA General Comment 2 and EPA Specific Comment 9.

17. Table B-3 row 10 (Discharge Water), columns 2 and 3;

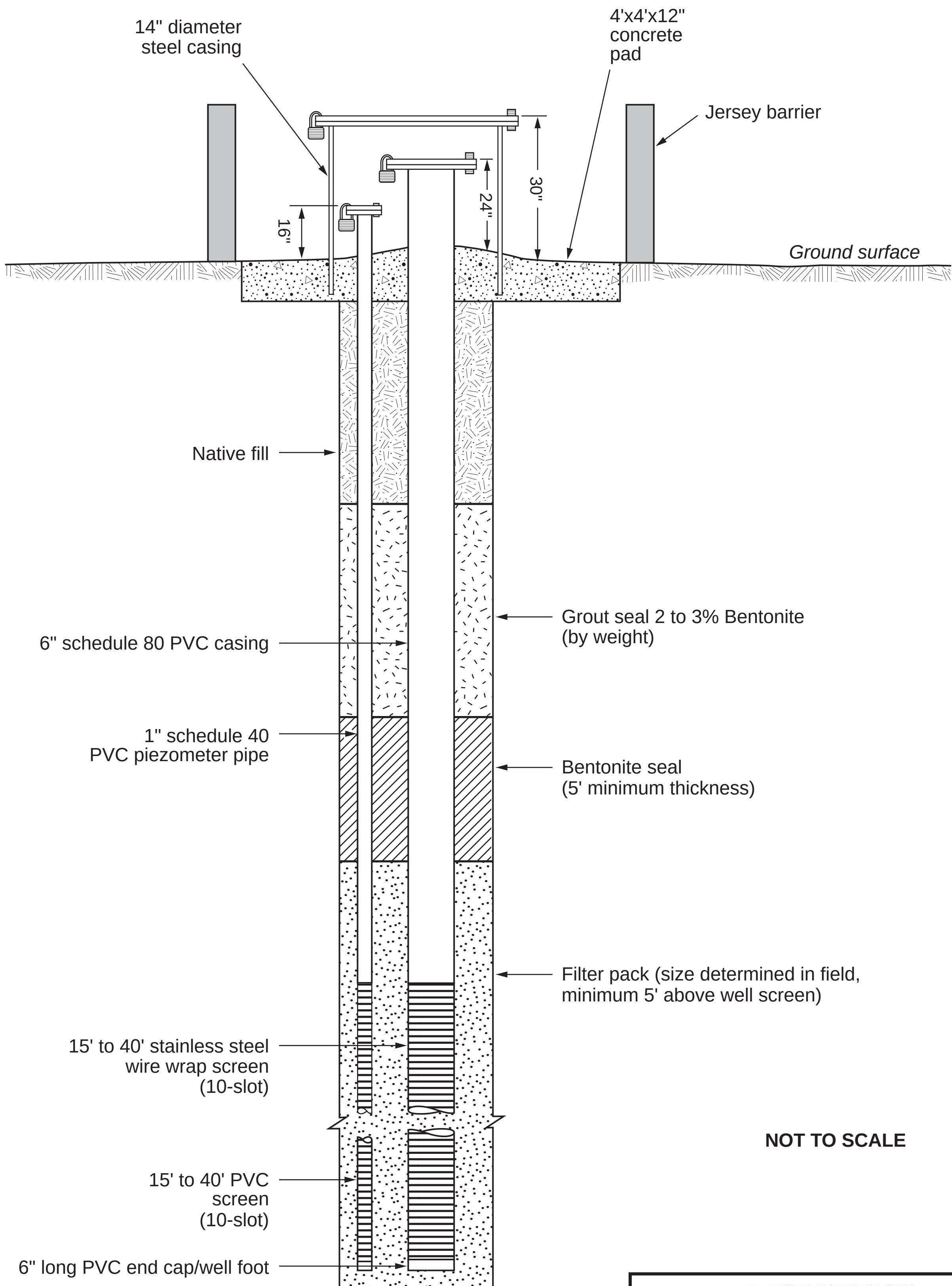
Insert "in" between 'collected' and 'tank(s)'.

FMC Response: The typographical error will be corrected.

18. Page B-14, section B.4.1.1, step 9 and section B.4.2.1 step 2;

This discussion leads the reader to conclude the data loggers will be set after the start of pumping, resulting in the loss of early time data. Please revise the text to clearly state data loggers are to be set prior to the start of pumping.

FMC Response: MWH field personnel have successfully performed numerous pump tests following this standard operating procedure (SOP) and disagree that the SOP is ambiguous regarding the fact that the pressure transducers and data loggers are installed and programed to begin logging prior to initiation ("Test Start-Up") of pumping from the test well(s). No revision of the Work Plan is warranted.



Total Depth Approx. 120 feet
(approximate depth to top
of American Falls Lake Bed)

FILE Fig 3-2_Generalized Extraction Well Design_mod2.ai DATE: 17 Oct 2013

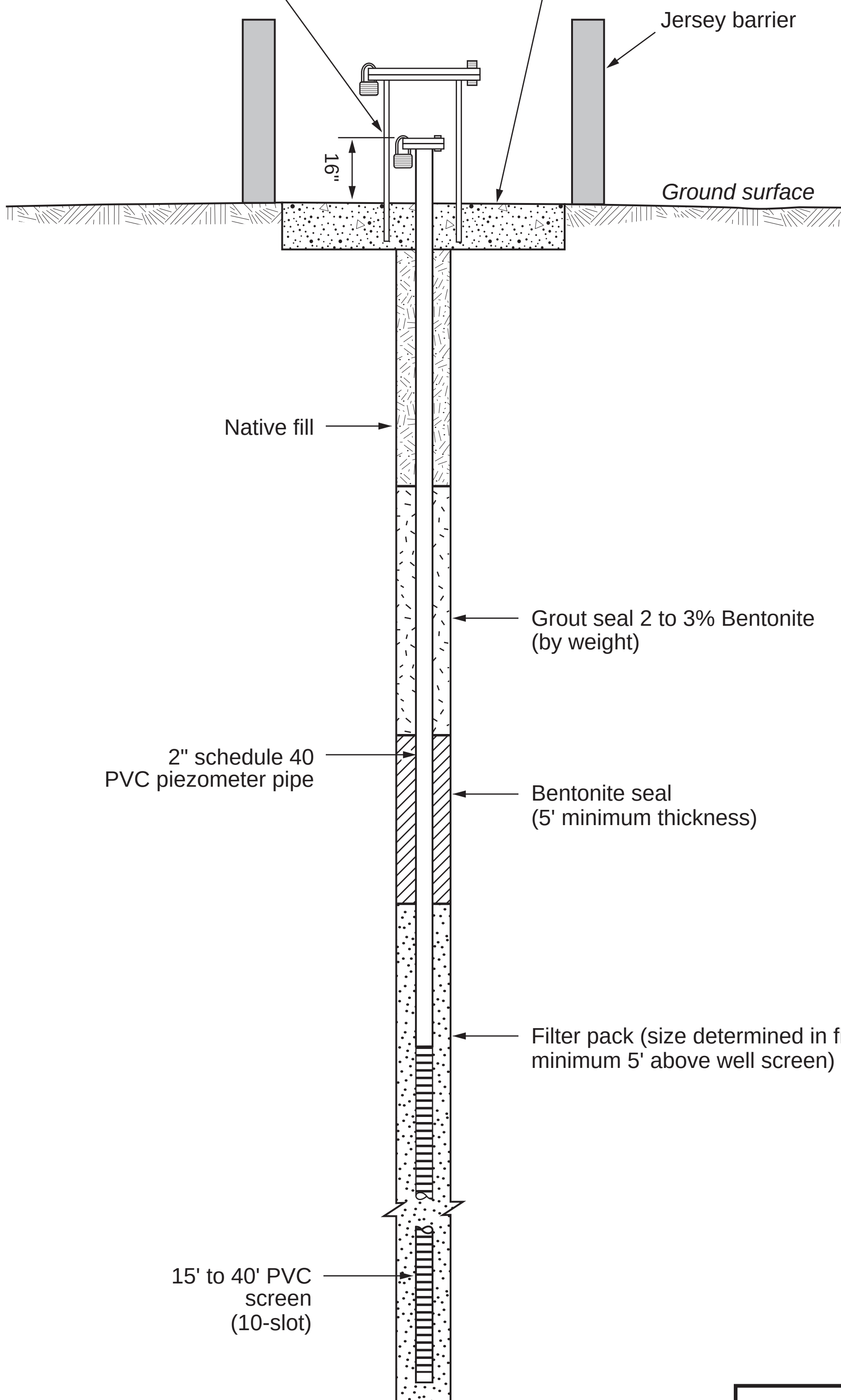
MWH

FMC

HYDROGEOLOGIC STUDY WORK PLAN

FIGURE 3-2

GENERALIZED
EXTRACTION WELL DESIGN



Total Depth Approx. 120 feet
(approximate depth to top
of American Falls Lake Bed)

NOT TO SCALE

MWH

FMC

HYDROGEOLOGIC STUDY WORK PLAN

FIGURE A-1
GENERALIZED PIEZOMETER
DESIGN AND ABOVE-GROUND
COMPLETION

FILE *Fig A-1_Generalized Piezometer Design and Above Ground Completion.ai* DATE: *24 Oct 2013*

APPENDIX E

Referenced EMF RI Table and Figures

TABLE 3.3-1

TABLE 3.3-1

HYDRAULIC CONDUCTIVITIES AND TRANSMISSIVITIES OF EMF AQUIFER SYSTEM

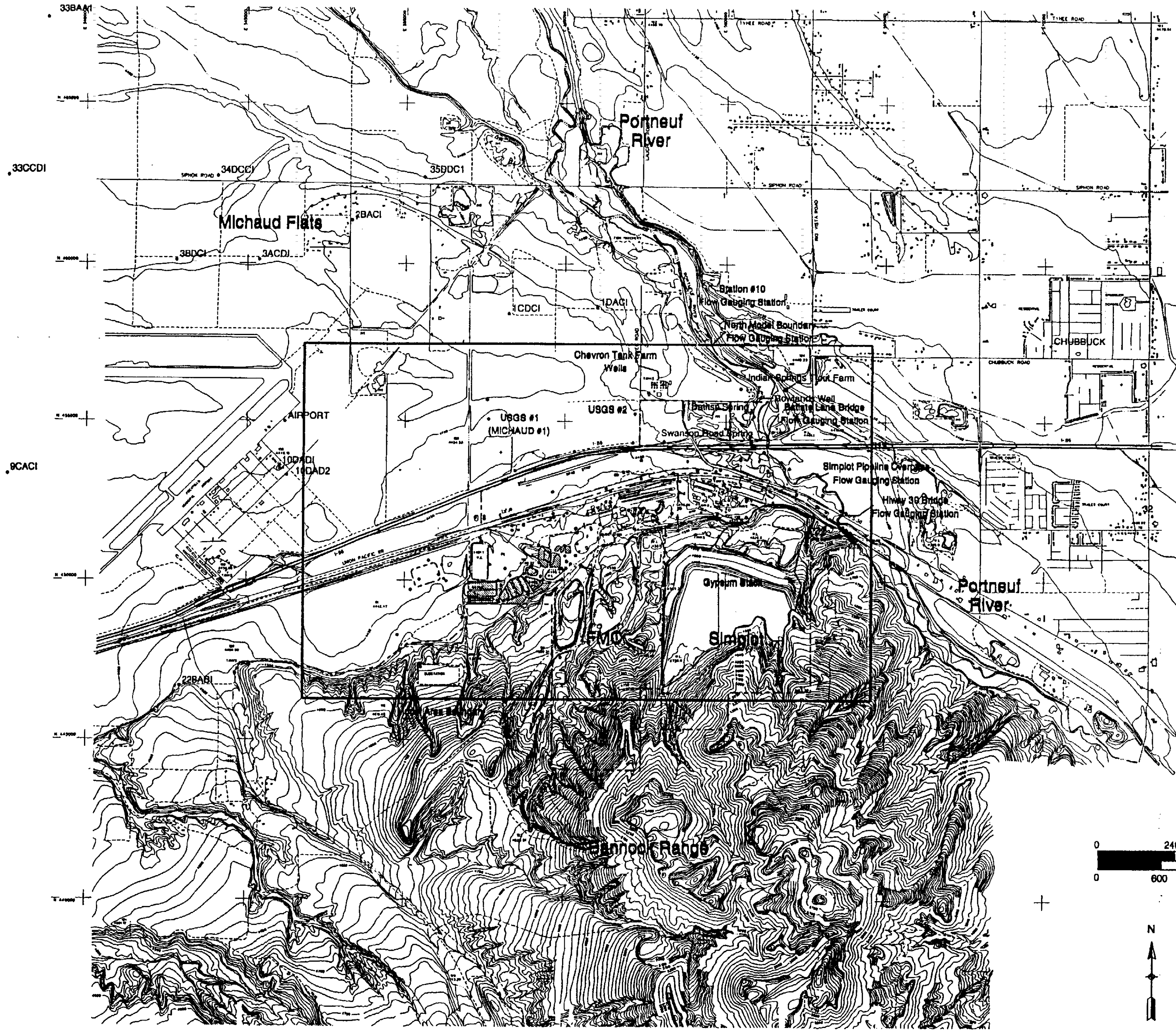
	Shallow Wells	Hydraulic Conductivity cm/s	Hydraulic Conductivity ft/day	Type of Test	Source
MICHAUD FLATS	104	4.45E-02	126	Slug Test	BEI
	108	1.01E-01	286	Slug Test	BEI
	110	3.80E-02	108	Slug Test	BEI
	111	1.40E-01	397	Slug Test	BEI
	113	1.40E-01	397	Pumping Test	BEI
	126	5.85E-02	166	Slug Test	BEI
	134	1.09E-01	309	Slug Test	BEI
	135	3.15E-02	89.3	Slug Test	BEI
	139	1.90E-02	53.9	Slug Test	BEI
	140	9.70E-02	275	Slug Test	BEI
	146	6.10E-02	173	Slug Test	Hydrometrics
	148	2.45E-02	69.5	Slug Test	Hydrometrics
	150	3.55E-01	1000	Pumping Test	BEI
	153	3.30E-01	935	Slug Test	BEI
	154	1.74E-02	49.3	Slug Test	Hydrometrics
	501	9.05E-02	257	Slug Test	BEI
	514	3.92E-02	111	Slug Test	Hydrometrics
	515	1.05E-02	29.8	Slug Test	Hydrometrics
	516	2.33E-02	66.0	Slug Test	Hydrometrics
BANNOCK RANGE	106	4.30E-03	12.2	Slug Test	Hydrometrics
	142	7.00E-04	1.98	Slug Test	BEI
	300	2.43E-04	0.69	Slug Test	Hydrometrics
	301	1.00E-05	0.03	Slug Test	BEI
	304	4.95E-04	1.41	Slug Test	Hydrometrics
	306	1.17E-03	3.32	Slug Test	Hydrometrics
	307	9.91E-02	281	Slug Test	Hydrometrics
	308	2.51E-02	71.2	Slug Test	Hydrometrics
	313	1.80E-02	51.0	Slug Test	BEI
	316	1.02E-02	28.9	Slug Test	BEI
	323	1.20E-03	3.40	Slug Test	Hydrometrics
	325	5.45E-03	15.5	Slug Test	BEI
	333	9.91E-03	28.1	Slug Test	Hydrometrics
	PEI-2	1.00E-03	2.83	Pumping Test	PEI
	PEI-5	4.50E-04	1.28	Pumping Test	PEI
PORTNEUF RIVER	312	1.40E+00	3970	Pumping Test	BEI
	318	1.40E-03	3.97	Slug Test	BEI
	324	5.45E-02	154	Slug Test	BEI
	327	1.18E-01	334	Slug Test	Hydrometrics
	328	1.84E-01	522	Slug Test	Hydrometrics
	502	1.39E-01	394	Slug Test	Hydrometrics
	503	1.68E+00	4760	Slug Test	BEI
	505	3.66E-01	1038	Slug Test	Hydrometrics
	507	6.40E-01	1810	Slug Test	BEI
	517	7.20E-01	2040	Slug Test	BEI
	518	1.49E-01	422	Slug Test	Hydrometrics

	Deep Wells	Hydraulic Conductivity cm/s	Hydraulic Conductivity ft/day	Type of Test	Source
MICHAUD FLATS	103	5.20E-03	14.7	Slug Test	BEI
	107	2.20E-02	62.4	Slug Test	BEI
	109	5.15E-03	14.6	Slug Test	BEI
	125	7.22E-02	205	Slug Test	Hydrometrics
	133	1.20E-01	340	Slug Test	BEI
	145	2.15E-01	609	Slug Test	BEI
	500	6.70E-02	190	Slug Test	BEI
BANNOCK RANGE	315	1.19E-02	33.7	Slug Test	BEI
PORTNEUF RIVER	311	8.60E-04	2.44	Slug Test	BEI
	317	9.90E-03	28.1	Slug Test	BEI
	319	1.00E-02	28.4	Slug Test	BEI
	321	1.50E-01	425	Slug Test	BEI
	322	2.80E-01	794.7	Pumping Test	BEI
	329	3.65E-01	1030	Slug Test	BEI
	330	5.64E-02	160	Slug Test	Hydrometrics
	504	7.10E-02	201	Slug Test	Hydrometrics
	506	2.30E-01	652	Slug Test	BEI
	512	5.80E-01	1640	Slug Test	BEI
	519	1.59E-02	45.0	Slug Test	Hydrometrics

	Production Wells	Transmissivity (ft^2/day)	Transmissivity (gpd/ft)	Type of Test	Source
MICHAUD FLATS	FMC-6	7370	55130	Pumping Test	BEI
	32ACD1	35100	262550	Pumping Test	USGS
	32DDC1	135700	1015000	Pumping Test	USGS
	33BAA1	21900	163810	Pumping Test	USGS
	33CCD1	41400	309670	Pumping Test	USGS
	34ADD1	40400	302190	Pumping Test	USGS
	34DCC1	36600	273770	Pumping Test	USGS
	35DDC1	164400	1229700	Pumping Test	USGS
	3ACD1	41200	308176	Pumping Test	USGS
	3BDC1	444000	3321100	Pumping Test	USGS
	4BBA1	38500	287980	Pumping Test	USGS
	5BDA1	36800	275260	Pumping Test	USGS
	8ADA1	27300	204200	Pumping Test	USGS
	9CAC1	199000	1488500	Pumping Test	USGS
	12BBC1	54700	409160	Pumping Test	USGS
PORTNEUF RIVER	SWP-7	227270	1700000	Pumping Test	Simplot

References: BEI = Bechtel Environmental, Inc., Preliminary Site Characterization Summary for the Eastern Michaud Flats site, January, 1994
PEI = PEI Associates, Inc., Evaluation of Waste Management for Phosphate Processing, April 1985
Hydrometrics = Hydrometrics, Inc., Hydraulic Conductivity Testing of Existing Well Sites at the Eastern Michaud Flats Site, Pocatello, Idaho, April 1994
USGS = United States Geological Survey, Water-Resources Investigations Report 84-4201, Hydrogeology of Eastern Michaud Flats, Fort Hall Indian Reservation, Idaho
Simplot = J.R. Simplot files
FMC = FMC files

Hydraulic conductivity at Well 318 not used in K-zone mapping due to potential precipitation reactions in formation related to mixing of low pH water with groundwater.
Transmissivity at Well 311 not used due to possible grout contamination in filter pack.



Legend

35DDC1 • Boring and Well Locations
(See Figure 3.3-3 for Base Map & Well Designations Within Model Boundary)

Old Ponds (FMC)

Model Boundary

EMF Property Boundary

0 2400 4800 FEET

0 600 1200 METERS

N

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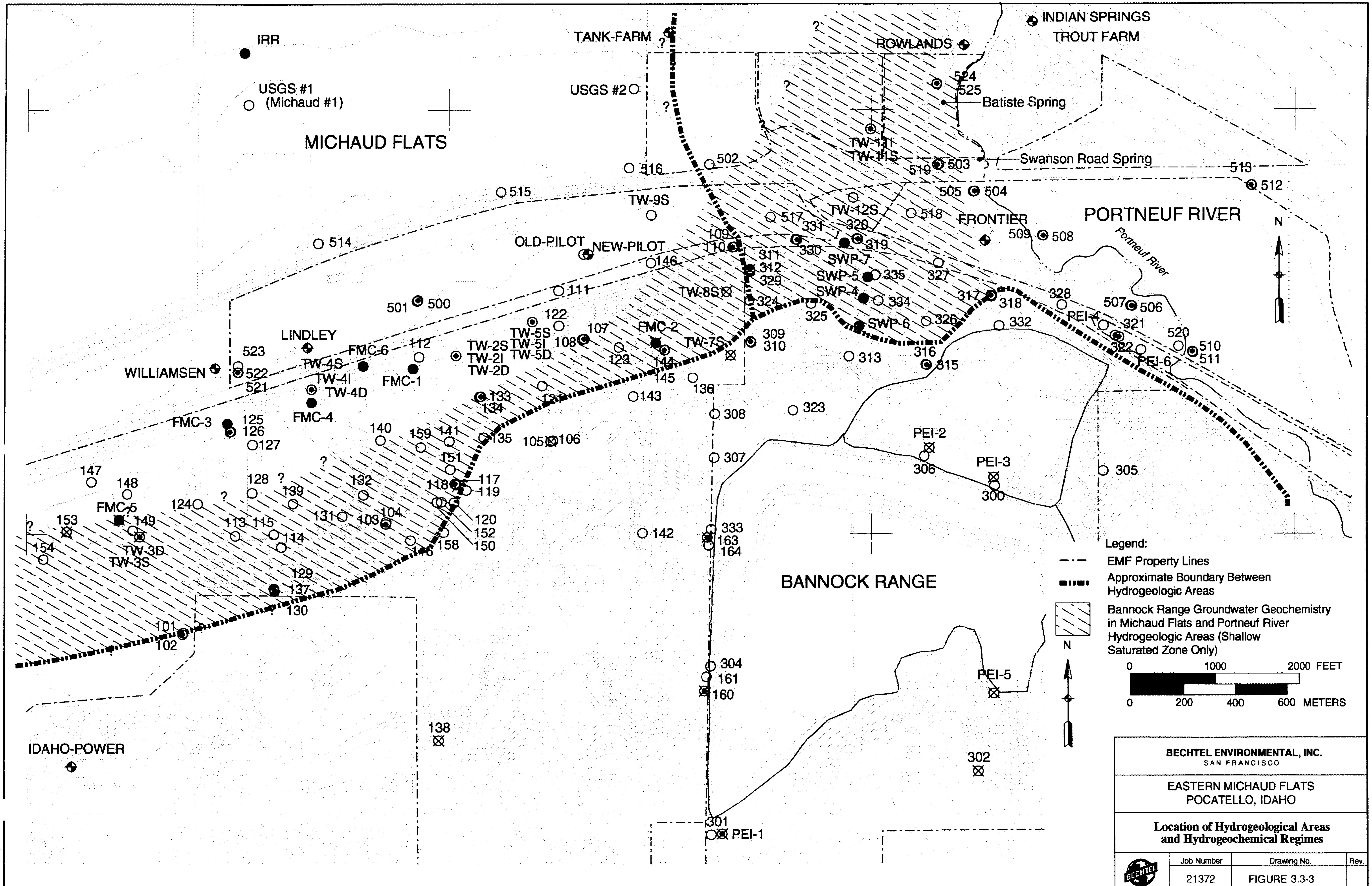
EASTERN MICHAUD FLATS
POCATELLO, IDAHO

EMF Flow Model Study Area

Job Number	Drawing No.	Rev.
21372	FIGURE 3.3-2	



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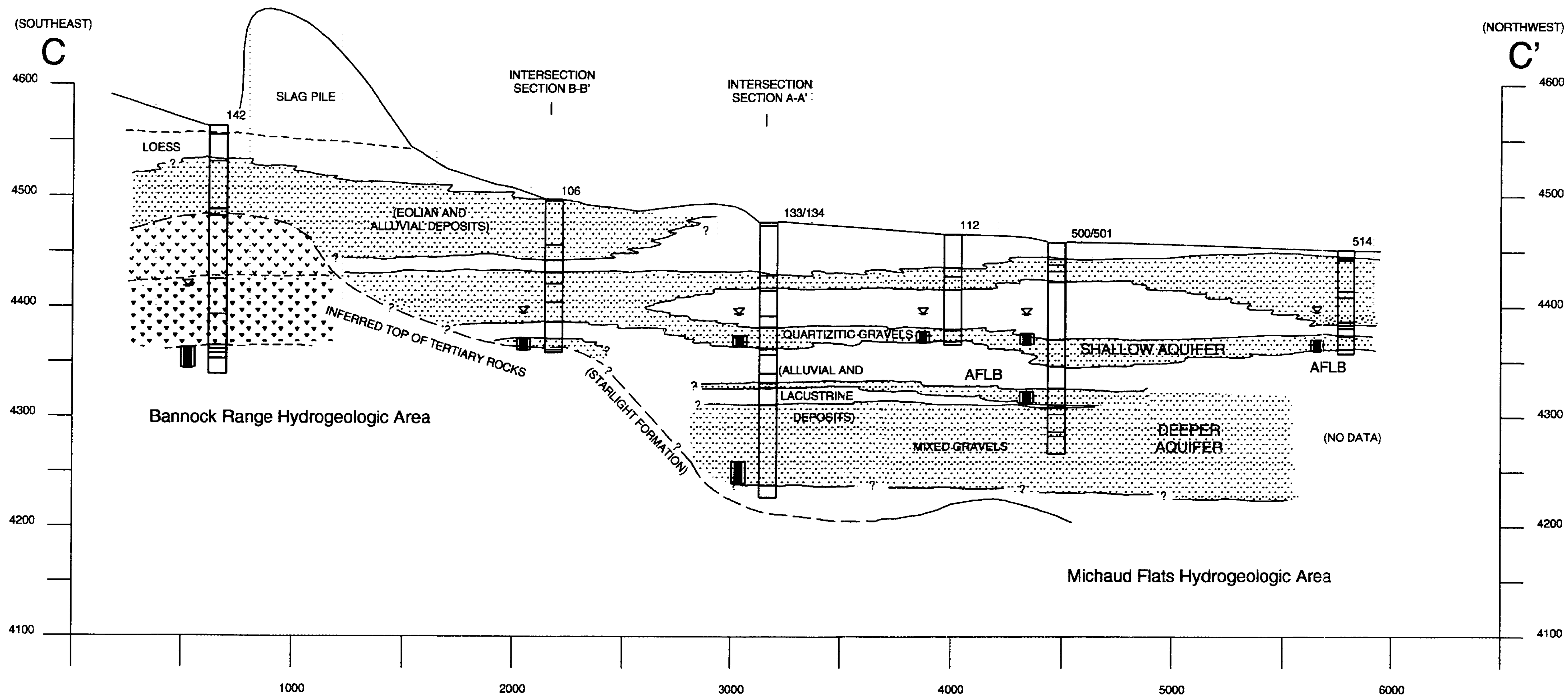
Location of Hydrogeological Areas and Hydrogeochemical Regimes

Job Number	Drawing No.	Rev.
21372	FIGURE 3.3-3	

EMF emfhgch2.dgn 1/10/



Notes:

1) Ground surface line generalized.

2) Vertical exaggeration = 5x

3) Cross-section is generalized.
See boring logs in Appendix for further details.

4) Cross-section lines are shown in
Figure 3.1-5.

5) AFLB = American Falls Lake Beds

Legend:

Water level

Well screen

SAND
GRAVELLY SAND
SILTY SAND
CLAYEY SAND
SANDSTONE
GRAVEL
SAND AND GRAVEL
SILTY, SANDY GRAVEL
SILTY GRAVEL
CLAYEY GRAVEL

SILT
CLAYEY SILT
SANDY SILT
GRAVELLY SILT

CLAY
SILTY CLAY
SANDY CLAY
GRAVELLY CLAY

BASALT
RHYOLITE
TUFF

CALICHE
PEAT

ASPHALT
CONCRETE
FILL

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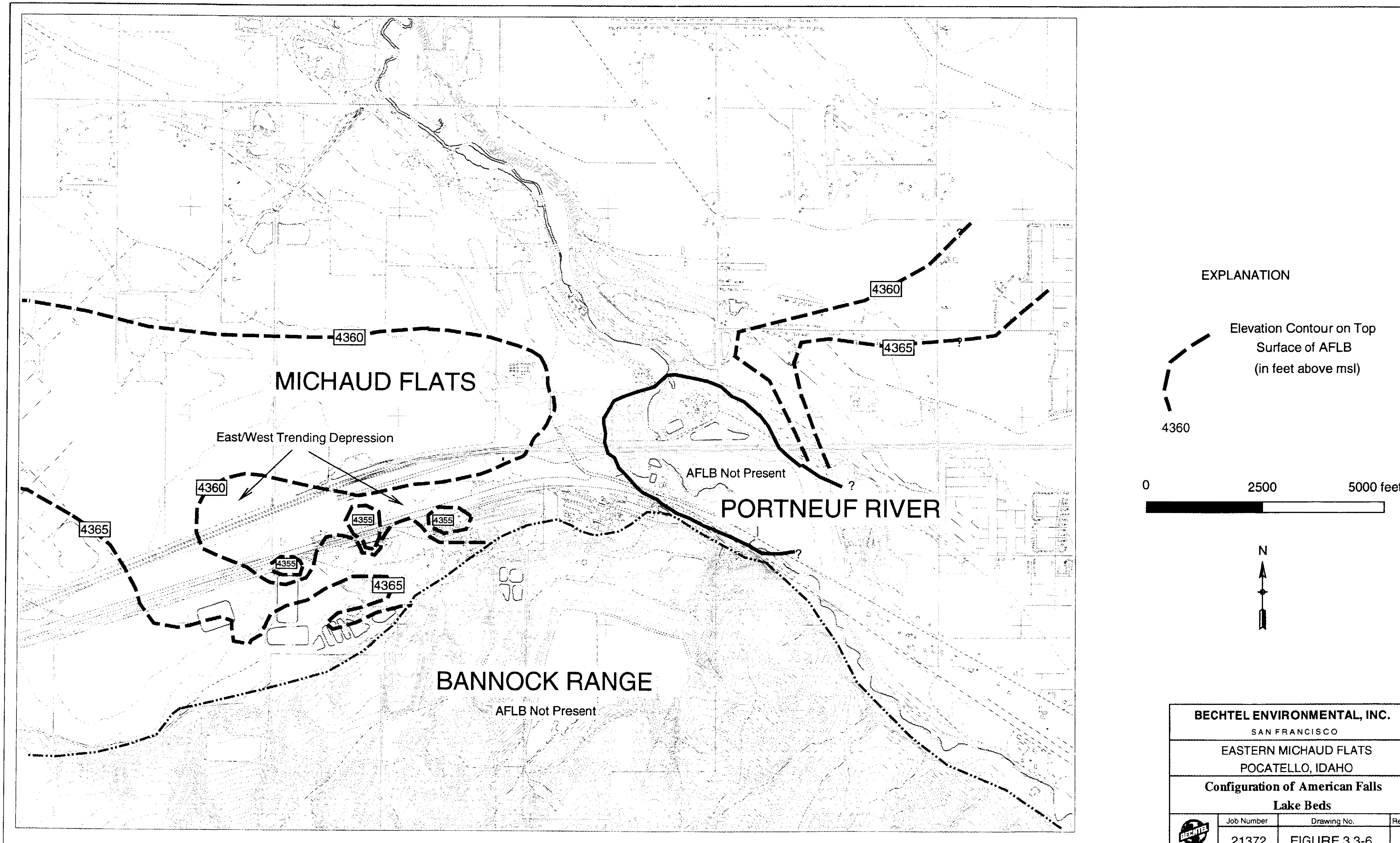
Hydrogeologic Cross-Section C-C'

Job Number	Drawing No.	Rev.
21372	FIGURE 3.3-4	



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EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Configuration of American Falls Lake Beds

Job Number	Drawing No.	Rev.
21372	FIGURE 3.3-6	